ANNALS OF SURGERY

VOL. XL NOVEMBER, 1904 No. 5

ORIGINAL MEMOIRS.

BACILLUS PYOCYANEUS SEPTICÆMIA ASSOCIATED WITH BLASTOMYCETIC GROWTH IN PRIMARY WOUND.

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THE rôle played by the bacillus pyocyaneus in the various pathologic conditions in which it is met has been subject to much discussion and debate. Some maintain that it exists merely as a saprophyte; others maintain, and the weight of recently accumulated evidence would seem to support this view, that it must be considered as a definite etiological factor capable of exciting very diverse morbid phenomena.

The bacillus pyocyaneus was discovered by Gessard in 1882. It was isolated from dressings soiled with so-called blue pus. He regarded it purely as a saprophytic organism which in itself was incapable of producing symptoms in man. In 1889, Charrin published his admirable researches. He was able to produce readily and constantly by injecting the bacillus pyocyaneus into rabbits a condition characterized by a fairly constant symptom complex. Albuminuria, a low grade of fever, diarrhœa, loss of weight, and a spastic paralysis of the hind quarters formed the essential symptom train of Charrin's

"maladie pyocyanique." Autopsy examination showed vasomotor disturbances in the various mucous membranes as well as viscera.

In 1891, Schaefer published in Berlin the results of his experimentation with the bacillus pyocyaneus injected in the dog. His results were quite similar to those published two years before by Charrin.

About this time, Cadeac, working independently of the two observers previously mentioned, published a report of a case of general pyocyaneus infection in a dog. In his case, the point of entrance of the bacillus could not be determined. The animal had died with symptoms of paralysis, diarrhœa, low grade of fever, and profound cachexia. The bacillus pyocyaneus was found in the blood, lungs, spleen, and intestinal tract, post-mortem.

Although the pathogenesis of the bacillus pyocyaneus in lower animals was no longer in doubt, its ability to excite definite morbid phenomena in man was still a matter of dispute.

To Gruber belongs the credit of having first proven conclusively the ability of the bacillus pyocyaneus to produce definite lesions in man. He isolated the organism from a case of middle-ear disease, and reported his findings with such thoroughness as to remove all doubt as to the pathogenesis of this organism towards the human species. Martha about this time also reported two cases of purulent otitis media from which pure cultures of this bacillus were obtained. It has since been found in many parts of the body. The bacillus pyocyaneus is a pyogenic organism. Its most conspicuous rôle is the production of blue pus. However, like the other pyogenic organisms, it can develop in different parts of the body and produce very diverse symptoms.

Its presence in suppurating wounds is not so common as is ordinarily supposed. Jakowski found it only twice in 200 cases. In 800 autopsies held at Johns Hopkins, the bacillus was found in eleven cases. Lartigau found it three times in 100 autopsies.

It has been found in the sweat, in the saliva and sputum,

in fistulous tracts in both large and small intestines, in tuberculous cavities, in the blood in puerperal fever, in the pus of otitis media, in chronic mastitis, in tonsillitis, in diphtheritic inflammation of the œsophagus, in the saliva in noma, in meningeal exudate, in localized infection of the umbilical cord, in the pericardial exudate during life, in a case of tuberculous pericarditis, in ovarian abscess, in bronchial pneumonia, in ureteritis, in pyelonephritis, in intestinal ulceration, in hepatic abscess, in various skin lesions, principally of the ecthymatous type, in furuncle, in panophthalmitis, in ozæna, in acute angina, in bronchiectasis, in gangrene of the lungs, in ulcerative gastritis, in cholera nostras, in infant diarrhœa, in dysentery, in appendicitis, in pericarditis, in peritonitis, in bursitis, in arthritis, in acute endocarditis, in cystitis, in mastitis, in endocervitis, in orchitis, in gangrene of the nose, and in the stomach.

The studies made by Lartigau on an epidemic of dysentery caused by the bacillus pyocyaneus are of great interest and value.

In addition to the above widely diverse conditions caused by the bacillus pyocyaneus, the organism has been shown to produce general septicæmia. Ehlers early published a report of a case of general infection due to the bacillus pyocyaneus. Cases have since been reported by Oettinger, Jadkewitsch, Neumann, Schaefer, Karlinsky, Ledderhose, Krannhals, Kossel, Calmette, Williams, Lavender, Triboulet, Williams and Cameron, Pes and Gradenigo, Le Noir, Kruse and Pasquile, Lartigau, Perkins, and Barker. The authors' case hereinafter described was one of general pyocyaneus infection.

A large number of the cases reported occurred in young children and were characterized by fever varying in degree, profound intoxication, some diarrhœa, and varying nervous phenomena. Most of the cases exhibited small petechial eruptions, from which in a number of the cases the bacillus was isolated during life. In several of the cases, notably Le Noir's and Jadkewitsch's, the bacillus was isolated from the urine during life. However, in the majority of cases, the diagnosis

was made post-mortem. Jadkewitsch's case was particularly interesting. It had many features in common with the authors' case.

JADKEWITSCH'S CASE.—When the case first came under observation, a chronic eczema was noted on both legs. It was very painful, the patient seeking treatment for the relief of this pain. He had had this eczema for ten years. At times it had given him but little trouble, but he had had severe ulcerations in an eczematous patch on his lower right limb several times. At the time the patient presented himself he had but recently recovered from a severe ulceration of his right leg of nearly three months' duration. This ulceration differed from that in previous attacks he had suffered in that the pus was blue, staining the dressing deeply in a very short time. From the report of the case it was evidently a case of typical blue suppuration. The pus gradually disappeared under local treatment, and when first seen by Jadkewitsch was entirely gone, the patient presenting himself for treatment of the chronic painful eczema and for a nervous condition. He had developed paresis with anæsthesia of the whole right arm. This disappeared in seven weeks under appropriate electrical treatment. One month later blue suppuration again appeared, lasting three weeks. It was accompanied by great weakness and emaciation, dyspnœa, a slightly subnormal temperature, and a very rapid pulse ranging from 130 to 145. This lasted for four months, when recovery took place.

Nearly two years later blue suppuration again appeared in the leg. It persisted for four months, with slight intermissions lasting from two to four days. This attack was characterized by diarrhœa, slight elevation in temperature, never exceeding 38.1° C; pulse-rate from 120 to 135, profound prostration, paresis of both legs, and localized disturbance of sensibility. The lips and tongue were anæsthetic. The bacillus pyocyaneus was isolated from the urine by Jadkewitsch. No statement is made in his report whether the organism was recovered from the blood. The patient recovered from this attack, and no subsequent report has been made of the case.

AUTHORS' CASE.—Patient, Miss B., aged seventeen years, American, admitted to hospital December 13, 1903.

Family History.—Father, mother, four brothers, and one sister are living. There is no history of tuberculosis, syphilis, or nervous disease in the family. Patient herself has had the usual diseases of childhood. When nine years old she had measles, with abscess formation in the right ear. She has also had whooping-cough; has had two attacks of pneumonia,—one in the spring of 1902, lasting four weeks, the other in the spring of 1903, when the patient was in bed six weeks; has had slight rheumatism since she was six years old, the attacks usually following exposure, and characterized by sharp pains in the lower limbs and joints.

The patient, a school-girl, has led the usual life of a pupil in a country school. Her habits have been good, and, excepting the diseases of childhood previously mentioned, has, prior to the present illness, been in good health.

On November 18, 1901, in a runaway accident, she was thrown upon a hard macadamized road. She fell on her left side and lay unconscious for fifteen minutes. Upon regaining consciousness she complained of a sharp stinging pain in her left arm, but motion in the arm and fingers, although painful, was possible. Her fingers were numb. She walked to her home, a distance of half a mile. The accident happened on the 18th of the month, but a physician was not summoned until the 21st. At that time her left arm was swollen from fingers to shoulder. There was no discolorization. Movement at the shoulder-joint was normal and painless, but there was great pain when active or passive motion was attempted in the elbow-joint. Muscular power in the hand was decreased. The attending physician applied pressure bandages, but the swelling did not subside. The patient remained in this condition until April, 1903, when she sought treatment elsewhere. The arm was no longer painful, but there was no sensation in the fingers. The arm was now blistered on its outer posterior surface, in all covering an area about two and one-half inches wide by four inches long. No improvement resulted, and soon she became, as the rather unsatisfactory history has it, "completely paralyzed on the left side." She could not move her left arm or leg and had difficulty in swallowing.

She was then taken to Chicago, and was presented in the dispensary clinic of Northwestern University Medical College by Dr. D'Orsey Hecht. After careful examination, the diagnosis of "traumatic hysteria" was returned. She steadily improved under treatment, but returned home in three weeks. On June 19 an operation was performed by her local physician "to relieve pressure on the musculospiral nerve." An incision two inches long was made. The wound healed perfectly. Symptomatically, the operation was not a success, and she was therefore reoperated on July 28.

She soon regained sensation in her hand. The wound healed slowly, and at the end of the fourth week, excepting an area about the size of the end of the little finger, was covered with epithelium. The arm was entirely free from pain and there was no swelling. The wound was dressed with a 10 per cent. iodo-

form gauze dressing. At the end of the fifth week after operation, three small blisters, each about the size of a millet-seed, developed in the small area of granulating tissue still uncovered with epithelium. These rapidly increased in size, and in twenty-four hours became confluent, covering the entire granulating area. In a few hours, the one large blister broke, discharging a thin, clear, watery substance. The process was extremely painful and abrupt in onset.

Mode of Onset.—She was seized with a slight rigor accompanied by great pain in the region of the wound. The pain was at first of a boring character. It soon changed to a dull burning, and was so severe that two repeated hypodermatic injections of morphine sulphate, grains one-quarter each, were given. She complained of heat and soreness in the skin surrounding the area visibly involved. There was no itching or cracking of the skin. By the fifth day, a round area a little larger than a twenty-five-cent piece was involved. It was "one big blister," which broke and refilled every four or five hours. The discharge now assumed a grayish tinge. She was at this time in great pain, but not delirious or prostrated.

On the sixteenth day the wound took on a blue tint. In a few hours the entire surface was of light blue color. Blisters no longer formed, but the surface exuded a thin, watery fluid. This was tinged blue, and the dressings when removed were quite deeply stained. The wound was curetted and carbolic acid (5 per cent. solution) applied locally. The dressing was changed once every hour. However, in spite of all treatment, the condition gradually spread, until in seven weeks an area as large as the palm of the hand was involved. At times it was light blue, then darker blue, portions becoming dirty brown. All shades from light blue to the dirty brown could be seen in the wound at once. The discharge remained watery and thin and of blue color.

About two weeks after the appearance of the blue discharge she began to feel "a general uneasiness." She started violently and jumped at the slightest sound. The opening of a door caused her to shake with fear. This was followed by a feeling of dizziness. She had severe headache that lasted for hours, and complained continuously of severe pain in the back of her head. She answered questions intelligently, but was unable to remember. Her face, arm, and leg muscles twitched involuntarily. In all, she was profoundly prostrated.

The wound on the arm resisted all efforts to heal it. It was curetted and strong antiseptics applied, but the blue film would return in a few days, even under frequently changed and strong moist bichloride dressings. The X-ray was used for two weeks, a low vacuum-tube being applied four inches from the wound every other day for ten minutes. The wound was cauterized with the Paquelin cautery, the diseased tissue burned out; the cauterization being carried well beyond the seeming margin of the ulcer and deeply below the base. However, nothing had been of marked benefit, the process being entirely unaffected by the X-ray treatment, and recurring quite promptly after the cauterization. The wound was again curetted and pure carbolic acid applied, this also without benefit, the condition returning inside of a week as seriously as ever. The pain in the arm was so great that morphine was given frequently. The chronicity of the condition was distressing to the patient and her family, largely because of the extreme and steady pain, and it was for the relief of this that she determined to have the arm amputated, coming to the hospital for this purpose.

Status at the time case first came under the writers' observation. Patient very weak; unable to walk without being supported. Mother stated her normal weight to be 135 pounds. She then weighed ninety-two pounds. She walked with an unsteady, reeling gait, but stated that she was not dizzy. She tired on the least exertion. She had no cough. Her appetite was fitful; at times she desired food, but eating generally nauseated, and frequently caused vomiting. She had been markedly constipated, sometimes having had only one scanty bowel movement a week.

Urination had been difficult at times, and some time previously she had been catheterized for a whole week. Urination was never painful; she was simply physically unable to evacuate the bladder.

Menstrual History.—Began at fifteenth year, normal in every way until November 3, 1903, when menses ceased. This phenomenon has not appeared since.

Body in General.—Slender frame, height five feet one inch, symmetrical, no anomalies of development, musculature good but flabby, panniculus adiposus poor, large and heavy bones.

General State.—Markedly depressed; she answered questions in a disconnected manner, and was not interested in her surroundings. She seemed almost in stupor, it being difficult

to arouse her. Occasionally she uttered a low moan. She had not been delirious. She lay in the same position for half an hour at a time, not attempting to arrange herself comfortably, even though the position assumed be an uncomfortable one. She had slept but little for several weeks, the extreme pain in the arm and head making it impossible. She complained of a dull ache in the back of her head. Temperature and respiration normal; pulse, 101.

Skin.—On the face, body, and lower limbs clear and of good color, but cold and moist. There were no scars or eruptions. Skin of left arm on its entire outer surface was bronzed, due to the use of the X-rays in treating the local ulcer. On the outer anterior surface of the left arm, occupying an area about the size and shape of the palm of the hand, was a large ulcer, its margins sharply defined and indurated, and the whole slightly elevated. The base of the ulcer was blue, the shade of blue varying in different parts of the ulcer; in some portions being light sky-blue, in others darker blue, while some areas were brown. The light blue areas were bathed with a thin watery fluid which stained the dressing blue. The fresh stains of the dressing were of a light shade of blue, but after half an hour's exposure to air the color changed to a darker blue (about the shade of Loeffler's methylene-blue solution). The brown areas were dried, hard, and firm. There was little or no exudation from these areas. They consisted of thin, very adherent crusts, the surface bleeding quite freely if irritated.

Scrapings were made from the surface of the wound and stained in Loeffler's methylene blue. The following rough findings were made at this preliminary examination:

Light Blue Areas.—An exudation from one to three millimetres thick extended over these areas.

The exudation was moist, and was readily removed with the platinum loop, causing no bleeding.

In consistence it resembled the scraping obtained from a caseated bronchial gland.

Dilution drops were made and cover-glass smears were stained with Loeffler's methylene blue. They took the stain readily. In these, upon examination, were found a large number of blastomycetes. They consisted of a central cell-body about the size of a red blood-cell surrounded by a capsule of equal thick-

ness. The capsule did not take the stain readily, but in a number of cases the outside rim of the capsule stained faintly. There were a few small bacilli in these sections and masses of detritus taking a heavy deep blue stain.

Brown Areas.—In the brown areas, scrapings were obtained with difficulty. The exudate was hard and dry and very adherent, so much so that when a portion was broken off for examination the denuded area bled freely. Examination of the scrapings of this area showed a few blastomycetes, all of them in a budding state. No bacteria were seen.

The wound was extremely painful, and the small amount of manipulation necessary in obtaining the scrapings caused great discomfort. Examination of the lungs, heart, and abdomen was practically negative. The spleen could easily be palpated. It was markedly increased in size, extending a full inch below the ribs with the patient in the reclining position. No enlarged lymphatic glands could be felt, but tenderness was present in the pit of the left axilla. There was neither redness nor œdema in this axilla.

The patient was placed under close observation and vigorous saline catharsis begun. Moist dressings of bichloride of mercury, 1–5000, were applied, the dressings being changed every half-hour day and night. There was no increase in temperature, although the pulse-rate was high.

The local condition on the arm did not improve. On December 15, under a general anæsthetic, the blue slough was removed, great care being taken not to button-hole the surface taken off or infect the fresh tissue with the area being removed. A fresh, clean surface was thus obtained. Moist bichloride-of-mercury dressings, 1–2000, were applied, and the dressing changed once an hour. The patient's mental condition improved at once. She became more cheerful; she no longer experienced the violent pains in her arm and head, answering questions readily. The wound on the arm was soon covered with healthy granulations. The base of the wound was largely composed of tissue of the cut arm muscles. These muscles could be seen occasionally to jerk and twitch. This was not painful.

On January 4 the patient sat up. She had been free from pain in the arm since the operation, made three weeks previously, and the granulating area on the arm was free from blue pus. The

wound was covered with an ordinary dry dressing and bandage. She attired herself in the dress which she had worn when she entered the hospital, and in a very few hours was seized with a violent chill. The abruptness of the onset was marked. A distinct chill lasting for about half an hour was followed by profuse sweating. Her arm at once became very painful. The bichloride dressings had been continued without interruption from the time of operation. Examination at this time was negative. Three hours later the arm was re-examined, and three small blue spots the size of pin-heads were seen. These were in the centre of the granulating area, and none were nearer than half an inch to the margin of the wound. These areas were carefully cut out and the spots cauterized with pure carbolic acid. However, the girl became more and more depressed.

Bichloride-of-mercury dressings, 1–3000, were now applied and changed every twenty minutes. The process spread rapidly in spite of this, and in ten hours the entire area of granulation was covered with a light blue membranous exudate, staining the dressings bright blue a few minutes after they were applied. The patient refused food, complaining continuously of the pain. The temperature remained normal or slightly subnormal. The pulse was rapid, ranging from 90 to 120, and of a light thready character. Stupor was very pronounced, at times it being almost impossible to arouse her. She did not become emaciated.

Cultures were made from the surface wound, January 7. The plates were developed at ordinary room temperature, which was hardly more than 65° F. The growth on the plates was slow.

1. On the third day, small grayish pin-point colonies appeared. Under low magnification these colonies were seen to be roundish in shape, with faintly defined borders. In the centre was a dark mass. The periphery shaded off into the medium, the whole being granular. There was no liquefaction. Agar-agar, glycerin-agar, and gelatin cultures were made. When the cultures and plates were taken into a warm room, the growth was very rapid. In twenty-four hours the colonies attained a diameter of from one-quarter to three-quarters of an inch, and liquefaction progressed rapidly, the centre becoming liquefied first.

2. On the eighth day, colonies of another variety appeared. They were round, elevated, and about half the size of a small millet-seed. They did not liquefy. Stab gelatin cultures and agar-agar and glycerin-agar cultures were made.

Cultures.—Colony 1. The growth from colony 1 proved to be that of the bacillus pyocyaneus. The growth was characteristic, liquefying gelatin rapidly and developing in funnel form. Green coloring matter (pyocyanine), soluble in chloroform, developed after the fourth day. After seventeen days all the gelatin was liquefied, and the culture was simply a mass of light greenish-colored fluid. This gradually darkened and became brown. On agar-agar and glycerin-agar a gray surface growth developed along the line of scrapings with the platinum loop. The growth was distinctly grayish and remained of this tint. At the eighth day the medium began to be tinted a faint green. The coloring extended far out into the medium from the surface of the growth. After two weeks, the entire mass of the medium was tinted a bright green. The growth, however, remained grayish.

Morphology.—With hanging drop and oil immersion the organism could be seen to be rapidly motile. It stained with ordinary aniline dyes and was a short bacillus with rounded ends.

Colony 2. The organism grew slowly in gelatin, no colonies appearing until the ninth day. The growth was along the entire line of the stab puncture and was greatest at the surface. It tended to spread over the surface of the gelatin. There was no liquefaction.

Cultural Characteristics.—Stab cultures in gelatin developed a growth along the entire line of puncture at ordinary room temperature. There were no gas bubbles, nor did liquefaction occur at any time. The organism developed slowly. Involution forms appeared. On the sixth day after the first appearance of the growth, two series of transplantations were started, one in which a new culture was made every four days and one in which a new culture was made every three days. The growth transplanted every four days lasted twelve generations, when it ceased to develop. The growth transplanted every three days lasted nineteen generations, when it ceased to develop. At the third generation in each series, the individual cell lost its capsule and became irregular in shape, varying from a round body, about half the size of a red blood-cell taking a deep stain, to an irregular oval body, the long diameter of which was about the size of a white blood-cell. The cells grew smaller and smaller, and in the ninth generation looked like a zooglia mass of irregularly shaped cocci, taking, however, a deep nuclear stain. Individual cells,

when seen separate and apart from a mass collection, did not show a capsule. On agar-agar (neutral reaction) and agar-agar litmus (alkaline) no growth developed. On glycerin-agar growth developed on the twelfth day and died out in three generations.

An attempt was made to grow the organism on wort gelatin; the results, however, being less encouraging than with plain nutrient gelatin, the organism dying in the fourth generation. The organism apparently developed as readily under practically anaërobic as aërobic conditions. A tube of gelatin was taken and inoculated as in an ordinary stab culture, and the contents of another tube of gelatin melted at a low temperature and poured in over the surface of the tube previously inoculated. A growth appeared in the deep portion one and one-half inches from the surface of the gelatin in nine days.

Morphology.—The organism stained readily with the ordinary aniline dyes, and was found to be about the size and shape of a red blood-cell, taking a very deep stain. Each cell was surrounded by a capsule of about the same thickness as the deeply stained portion of the cell. The capsule did not take the stain except at its outer margin, which stained faintly. The capsule was best demonstrated by the following technique:

1. Specimen stained in carbol fuchsin for five minutes, raising the stain to the boiling-point.

2. Washed thoroughly in water.

3. Decolorized for two minutes in one-half per cent. solution of hydrochloric acid in 80 per cent. alcohol.

By this technique the cell-body was stained deep red, but not so deeply as to mask the cell structure. Care was taken, however, in decolorizing not to completely remove the stain from the cell. By carefully decolorizing, the cell-body was seen to be highly granular with light unstained areas. No reticulum could be made out. The capsule stained a delicate pink, the outer margin of the capsule taking a distinctly darker tint. The stain was not permanent, the pink in the capsule disappearing in a few weeks. However, the rim of the capsule and the deep staining cell-body remain stained after two months.

The ordinary budding forms of blastomycetes were found after the third day in the culture.

On January 10, petri-dish plates were made from the blood.

Technique.—A. The ball of the thumb of the right hand (the ulcer was on the left arm) was carefully scrubbed with green soap and a stiff brush for fifteen minutes.

B. Washed with sterile water for ten minutes.

C. Washed in 95 per cent. grain alcohol for ten minutes.

D. Soaked in solution of bichloride of mercury, 1–1000, for ten minutes.

E. Washed in normal salt for fifteen minutes.

F. Washed in sterile water for fifteen minutes.

Surface of the thumb was scraped carefully with platinum loop and four petri-dish control plates were made. The thumb was then lanced and a free hæmorrhage obtained. The first few drops were removed with filter paper previously sterilized. Five petri-dish preparations were then made as follows:

Plate 1. Five drops of blood in a tube of three inches of gelatin.

Plate 2. Seven drops of blood in a tube of gelatin three inches deep.

Plate 3. Nine drops of blood in a tube of gelatin three inches deep.

Plate 4. Eleven drops of blood in a tube of gelatin three inches deep.

Plate 5. Twelve drops of blood in a tube of gelatin three inches deep.

Findings.—No growth of any kind developed on the plates made from the skin. Plates 2, 4, and 5 developed colonies which were alike in all cases. They were small and round,—grayish in color,—and grew rapidly at ordinary room temperature. After thirty-six hours they began to liquefy at the edge, and in four days the medium immediately around each colony was tinted a light bright green. Cultures were made from the colonies. They grew quite readily on agar-agar, glycerin-agar, and nutrient gelatin.

Growth in Gelatin.—This growth was rapid in its development, growing in the characteristic funnel fashion. Liquefaction began on the third day. On the fourth day a green tinge could be observed spreading out into the medium from the growth. In a week, the entire mass of unliquefied gelatin was tinged a bright green. Soon the entire mass of gelatin was liquefied and the entire liquid mass was green, but gradually grew darker and

darker, finally becoming brown in color. Before the mass became entirely liquefied, the green color was confined to the unliquefied medium, the flocculent growth being grayish and absolutely devoid of green.

On glycerin-agar and agar-agar the growth developed rapidly along the line of smear. In seven days the medium immediately beneath the growth was tinted green, the green spreading into the medium with great rapidity. In a week the entire medium was tinted green, but the growth was grayish, and remained so throughout, never acquiring the green tint so plainly seen in the medium. The organism was developed at ordinary room temperature.*

Morphology.—The organism proved to be a small bacillus with rounded ends about two and one-half to three times as long as wide.

Hanging-drop preparations showed a motile organism. Motion was lost after two days' growth in gelatin. Staining for spores gave a negative result. The organism, from its cultural and morphological characteristics, was identified as the bacillus pyocyaneus. Cultures were made following the technique de-

* We are aware that the technique used above is not the most approved one for making a bacteriological examination of the blood. We did not have on hand at that time the large quantity of bouillon necessary, so we did not draw off blood in a syringe and inoculate a large quantity of bouillon with a small quantity of blood, as is the usual method. However, the usual method, it seems to us, is preferable to the method used, only in that it is more liable to yield positive findings. By the use of the large quantity of gelatin, we in a way diluted the blood, and thus reduced to a certain extent the possible bactericidal action of the blood, which after all is one of the chief virtues of the methods in which large quantities of bouillon are used. Positive findings are of value, no matter what the technique, providing, of course, they are not subject to objection on the ground of inaccuracy. Great care was taken in every step in preparing the thumb to remove the possibility of contamination with organisms upon the skin, and we feel that the thumb was as aseptic as it is possible to render the living tissue. The non-development of the five control cultures made from the skin at the point of withdrawal adding evidence to our belief that there were no germs on the skin. The bichloride was mechanically, instead of chemically, removed by the normal salt and water, much time being taken and a large volume of fluid being used, so that we feel that the failure to obtain any growth from the skin scraping was not due, as is often the case, to a small amount of the bichloride being carried into the medium.

scribed above on January 14, 17, 20, 24, and 26. The drops were taken from different portions of the body each time and control cultures made in every case. In every instance the control culture failed to develop. On the 14th, 17th, and 20th, a pure culture of the bacillus pyocyaneus was obtained, but on the 24th and 26th we were unable to grow cultures. On the 26th only one petri-dish showed any development, it being the one in which there were twelve drops of blood, only one colony developing. In the preparation taken on the 24th and 26th there were no developments.

Urine Examination.—The urine was examined frequently, the following being a report of the first examination made.

Reaction, acid.

Specific gravity, 1027.

A. Soluble constituents.

1. Albumen test.
   a. Nitric acid and heat, positive.
   b. Acetic acid and ferrocyanide, positive.
2. Sugar.
   a. Fehling's and Boettgar's tests, both negative.
3. Bile.
   a. Iodine and Jolles' tests, both negative.
4. Diazo reaction, absent.
5. Acetone, absent.
6. Urea, quantitative estimation, normal.

B. Sediment, small in amount; composed largely of calcium oxalate crystals.

Examination was made daily. A varying amount of albumen was present; otherwise, the examinations were negative.

Blood Examination.—Marked leucocytosis was present, mostly of the polymorphonuclear variety. A few eosinophiles were seen. There was poikilocytosis.

These findings were of unusual interest in view of the symptom complex observed. The patient was evidently suffering from an acute intoxication of severe grade. She had no elevation of temperature; in fact, her temperature may be said to have been uniformly subnormal. Her respiration had been high, varying from 25 to 35, and her pulse small and running between 90 and 130. The most marked symptom was the marked degree of mental hebetude. There had been profound stupor for many weeks, at times approaching coma. Although the element of

hysteria was to some degree in evidence in the patient, it could hardly account for the profound depression and lack of ordinary intelligence. She was not marasmic. Removal of the only discoverable inflammatory focus, the ulcer on the arm, while it gave relief from the pain, did not completely relieve the pronounced symptoms of the toxæmia, the patient being restless and prostrated as before.

Treatment.—It is an interesting fact that the use of serum from immunized animals as a therapeutic measure has been proven to be of value in infections with the bacillus pyocyaneus; in fact, Bouchard prepared and used successfully an antipyocyanic serum four years before Behring gave to the world diphtheritic antitoxin. Bouchard's method of preparing the serum was very simple. A healthy rabbit was selected and inoculated with a sterile beef-tea culture of the bacillus pyocyaneus. This produced a slight reaction. The rabbit was then successively inoculated with increasingly stronger cultures of the living organism in the usual manner until an immunity was produced protecting it against an inoculation which otherwise would have been rapidly fatal to an unimmunized animal. Blood was then withdrawn and the serum secured in the usual manner. This serum was not only protective, but curative. It took about seven months to develop in an animal an immunity yielding a serum of value.

This serum, however, is not an article of commerce, and could not be found on the market, nor could any be obtained from any of the large biological laboratories. The case was therefore treated symptomatically.

A study of the reported cases of local infection by blastomycetes shows that the treatment giving most favorable results consists in the use of large doses of potassium iodide.

The patient was given fifteen drops of potassium iodide well diluted every three hours. Under ether anæsthesia the sloughing mass on the arm was excised. Ichthyol (10 per cent. in glycerin) was applied locally to the wound, the dressing being moistened with fresh solution every hour and changed every four hours. The application was non-irritating and, excepting the offensive odor, was agreeable to the patient.

On the third day after the operation she again complained of pain in the arm. The pain was not so great as it had been, yet was such as to cause fear on the patient's part lest a recurrence develop. Examination revealed nothing; the ichthyol discoloring the surface and masking it. On the sixth day, examination showed the margin of the wound to be hard and indurated. The patient complained continually of pain in the part, and, although examination revealed but little, the surface being masked by the ichthyol, there could be no question but that a recurrence had appeared.

The girl became decidedly more nervous and irritable. She jerked and twitched, and of necessity was watched to prevent her escape from bed. The pain in the arm became so intense that morphine sulphate, grains one-eighth, were given hypodermatically every three hours. This did not suffice to entirely relieve the pain. The pulse was high and rapid, ranging from 94 to 115. Her temperature ranged from 96.7° to 98.2° F. Only once did it reach 99°. Both temperature and pulse were lowest in the morning and reached their greatest height in the afternoon.

On January 20 it was necessary to discontinue the potassium iodide, as it could no longer be retained. An elixir of salicylic acid ten grains to the drachm was substituted, one drachm being given every four hours. This was well borne by the stomach. In three days, tincture of chloride of iron, drops fifteen three times a day, was added. However, the pain in the arm steadily increased, so that in twelve hours seven-eighths of a grain of morphine had been given her without relief from the pain. It was now decided to return to the potassium iodide, and ten drops were given every two hours. In three days the pain left the arm, and, although restless, nervous, and irritable, the girl did not seem to be in pain. The tincture of chloride of iron and the saturated solution of potassium iodide with local application of the 10 per cent. ichthyol were continued until the patient left our observation. The wound in the arm began to heal. When she left the institution, the wound was circular, with a diameter of about one-half inch. The margins were soft and the base on a level with the surrounding skin. She was sent to her local physician, with the recommendation that the treatment (frequently repeated large doses of potassium iodide and tincture of chloride of iron together with a local application of 10 per cent. ichthyol in glycerin) be continued. In a recent letter he states that the

wound is completely covered over with healthy normal epithelium, excepting an area as large as the nail of the little finger. He has reduced the dosage. The patient herself is leading an active out-door life and is apparently well.

While the patient was in the hospital her mother called. She stated that she had been "troubled with boils." Six weeks previously she had noticed a small, hard lump develop on the back of her left hand. It was about the size of a pea when she first noticed it. It gradually grew larger, until it reached the size of a small pigeon egg, when it gradually disappeared. At no time was it painful, nor was the overlying skin reddened or tender. It did not soften and break as she had expected it to do, but remained hard, gradually becoming smaller until it entirely disappeared. She did not open it nor break the skin. A few days after this had entirely disappeared, she noticed on the point of her elbow a hard, round body about the size and shape of a marble with a diameter of about half an inch. She herself states that it felt exactly like the growth which had appeared upon her hand. It was not painful or tender and had been there for some time, she thought, before she discovered it. It increased in size slowly, and on the advice of a friend she opened it with a needle. A thin, grayish, watery substance was discharged. Examination of the discharge showed it to contain blastomycetes in the budding form in great numbers. The budding was very marked; in fact, there were very few cells seen which did not show some budding. Examination of the axilla revealed a large, hard mass about the size of a hen's egg. The patient did not know it was there, as it was not painful and did not cause the slightest inconvenience. She was put upon potassium iodide and sent home.

The discharge in the elbow subsided shortly, but the large mass in the axilla broke, and discharged, according to the patient's statement, nearly two cupfuls of a thin, watery, grayish substance. No examination was made of the substance discharged. The patient has continued the use of potassium iodide, but she still has a discharge in the axilla. The patient stated at the time of examination that her son, a nineteen-year-old boy, had a similar discharge from his hip. A small kernel had developed to the size of a large hen's egg, had broken and discharged a thin, watery content similar to that seen in the mother. It had broken some three months before, but was still discharging. This is of peculiar interest in that we have three cases of blastomycetic

infection in the same family. In the mother and brother there was no apparent involvement of the skin and no pain, although in the sister this was quite marked.

Conclusions.—The interesting features of this case suggest the following conclusions:

First. There existed a general septicæmia caused by the bacillus pyocyaneus. The clinical manifestations were not such as would lead to the complete diagnosis, this resting entirely upon the bacteriological findings. There was every evidence of profound intoxication. It was accompanied by a very high pulse-rate with a temperature usually subnormal. Most of the cases heretofore reported have shown some elevation of temperature, with pulse-rate not so high as in the authors' case.

Second. Probably the most marked feature, and certainly one of diagnostic value, was the marked nervous involvement. It has been demonstrated that pyocyanine injected into guinea-pigs produces marked and violent convulsions. Large doses were fatal, while smaller doses produced an increased nervous irritability. In many respects the case is similar to Jadkewitsch's.

Third. The finding of blastomycetes in the local ulcer at once cleared our diagnosis, and explained the failure of the wound to heal. The combination of the blue pus bacillus infection with the blastomycetic infection was unusual. We have been unable to find any report of another similar instance in literature.

Fourth. We had in this case a clean incised wound healing by first intention. The wound became infected with blastomycetes primarily, with the bacillus pyocyaneus secondarily. Many cases of wound infection have been observed due to the bacillus pyocyaneus; but the ability of blastomycetes to infect clean wounds and produce delay of union, with destruction of tissue, is not generally recognized. While the complication is rare, owing to the limited distribution of pathogenic yeasts, still it should, we feel, be given more consideration than is now accorded it.

THE BRIDGING OF NERVE DEFECTS.[1]

A CONTRIBUTION TO THE SURGERY OF NERVES.

BY CHARLES A. POWERS, M.D.,

OF DENVER, COLORADO,

Professor of Surgery in the University of Denver.

It is difficult to make a satisfactory review of this subject. The operation itself deals with those cases in which approximation of the divided nerve segments—simple nerve suture—is impossible; but we know that ordinary neurorrhaphy, primary or secondary, is not invariably successful, for it happens only too often that under favorable conditions of approximation the functional result is far from perfect. In the present state of our knowledge it is not easy to give the percentage of failure in suture with good approximation, so that in attempts at bridging incoercible separation of the divided ends of a nerve we are uncertain as to how much of the success or failure depends upon factors which are not under the control of the operation itself. In other words, given a case in which some form of attempt at bridging has failed, it is impossible to say that a good functional result would have been secured had perfect approximation been obtained.

Other difficulties are referable to the manner in which the subject of nerve suture is treated in medical literature. The Index Medicus has no classification of it, and the writer[2] has endeavored to consult all of the sections which might bear indirectly thereon. Most of the studies on nerve surgery are hidden away in such sections as Operative Surgery, Surgery of the Extremities, Surgery of the Head and Face, etc. Such a condition has a twofold significance, for, while it argues some

[1] Read before the American Surgical Association, June, 1904.

[2] The author acknowledges his indebtedness to Dr. Edward Preble, of New York, for valuable aid.

defect in the method of indexing, it implies at the same time that the subject itself is not one of great importance or interest.

It might be thought that the enormous amount of material in the domain of surgery of the nervous system collected and published by Chipault should contain everything of interest upon the subject of nerve suture. But the "État actuel de la chirurgie nerveuse" contains no analytical index, and of the large number of references cited in the work which bear upon this subject very many—especially the inaugural dissertations of foreign universities—are inaccessible to the American reader.

Further, it should be emphasized that much of the material comprised in the literature of the subject consists of operations upon animals. Quite a number of authors whose names are mentioned in connection with the work—Vanlair, Assaky, and others—never reported cases in human surgery. Létiévant, who is much quoted for his pioneer work in this field, operated but twice on the human subject, and the result in each case was complete failure.

Finally, a large proportion of the operative cases are reported at a period before the establishment of a permanent result, and at a time when early return of sensation may be explained by collateral nerve supply, and early return of motion may be considered due to vicarious movements of other muscles than those formerly paralyzed. (Peterson.)

The subjects of nerve repair and regeneration, of simple neurorrhaphy,—primary and secondary,—and of the more simple and obvious means of approximation of the divided ends of nerves, such as stretching and posture, are fully discussed in a somewhat abundant literature, as are likewise such allied procedures as neurolysis, the implantation of a healthy nerve into the nerve of a paralyzed muscle, and the after-treatment of nerve suture, however performed, by electricity and massage.

On the other hand, the more unusual resources for restoring the continuity and functions of severed nerves have a relatively small literature, at least so far as attempts at con-

sidering the entire field in a single paper are concerned. Individual case reports abound, and in some of these attempts are made to consider the subject of bridging defects at some length, but actual monographic studies are but little in evidence.

In Chipault's " Chirurgie opératoire du systeme nerveux," 1895, we find a systematic account of this subject, but without a complete list of cases. In the same year Huber made a meritorious attempt to collect all of the recorded cases in which nerve defects were bridged (*Journal of Morphology*). His combined material amounted to some twenty-two cases, over half of which were examples of the grafting of foreign substances.

In 1894, Spijarny published, in an inaccessible Russian journal, a list of nearly 200 cases of nerve suture of all kinds found in literature, and of these thirty concerned the bridging of defects. There were eleven operations of flap-splitting, eleven of foreign grafts, one of implantation, one of *suture à distance,* four of tubulization, and one of resection of bone. This series is of no special value, for some cases are said to be recorded twice, while the tubulizations are in part cases of simple suture with the superaddition of tubulization.

There are also several inaugural dissertations which treat of bridging defects, but the writer has been able to consult only Ehrmann's " Contribution a l'étude de la suture de nerfs à distance," Paris, 1896. This author, while discussing all of the operations for bridging defects, confines his actual material to *suture à distance.*

There are a few monographic studies devoted to particular operations. Thus, Peterson (*American Journal of the Medical Sciences,* 1899) has certainly done all that was possible with the subject of grafting proper, relating twenty histories in all, several of which appear for the first time. Dumstrey, " Ueber Nervenpropfung," *Deutsche Zeitsch. f. Chirurgie,* lxii (1901–2), made a rather unsatisfactory attempt to collect the published cases of nerve implantation, a number being omitted. Ehrmann's thesis on *suture à distance* has already been mentioned; it contains all of the cases (three) of this operation to

date (1896). The writer does not learn that the subjects of flap-splitting and resection of bone have ever been submitted to a critical study.

The sections on nerve surgery in Chipault's monumental "État actuel de la chirurgie nerveuse," 1901–1903, contain much material of interest on bridging defects, although this occurs in scattered fashion.

As already intimated, it is doubtful if a complete series of cases of the bridging of nerve defects can be compiled. The plan pursued by Chipault in securing a surgeon from every country in the world to collect the material of his own land has made the list of inaccessible publications much larger than would otherwise be the case. Moreover, a study of the entire material of neuroma would probably lead to the discovery of cases of implantation, etc., which have escaped the compiler. Thus, Maydl and Kukula, who covered the material of Bohemia for Chipault's work, speak of two cases of nerven-plastik as having been done in that country, although details fail.

Excluding all doubtful cases, the material found is as follows: Grafting, 22; flap operations, 11; implantation,* 10; resection of bone, 7; *suture à distance,* 5; tubulization, 1. Total, 56.

Grafting.—In this section the writer will use Peterson's admirable analysis, after first inserting two cases not included therein, one being his own. These are as follows:

Durante (*R. Accad. Med. di Roma,* April 24, 1892), in removing a tumor (osteosarcoma) of the head of the fibula, was obliged to resect a portion of the external popliteal nerve. As it was found to be impossible to approximate the severed ends, he inserted a graft of five centimetres of a dog's sciatic, suturing it in place with catgut. After operation movements of toes and foot notably improved, particularly those of dorsal extension and abduction, sensation also improved. (Report made at the end of a month.) However, rapid recurrence of

* Only those cases are taken in which the operation was undertaken to correct a defect. Cases of implantation for the relief of facial and Duchenne paralysis are not included.

the malignant growth made it necessary to amputate the leg. Dissection showed that the graft had entirely disappeared. An accurately recorded result is not given. We simply gain the impression that th result was good at an early day after operation. This is a fair illustration of the difficulty which the writer has experienced in judging of the results in the cases found in literature. Generalities abound, but accurately recorded *late* results are scanty.

The Author's Case. Nerve Transplantation. Implantation of Four Inches of the Great Sciatic Nerve of a Dog in the External Popliteal of a Man. Result at End of Eight Years.

C. O., a young man of eighteen years, came under my care at the Denver City Hospital, May 10, 1896, with a history of having been run over by a railway train twelve hours before. On examination he was found to have a crush of the right great toe, deep lacerated wounds of the right gluteal region, and a fairly extensive lacerated wound at the outer aspect of the right knee with a compound, comminuted fracture of the head and neck of the right fibula. There was complete anæsthesia and paralysis of the parts supplied by the external popliteal nerve. Dirt and coal-dust were ground into all of the wounds. Under ether the toe was amputated, the gluteal wounds cleaned and sutured, comminuted fragments of the fibula removed, and the lacerated wound at this point trimmed, cleaned, and partly sutured. The popliteal nerve was not found in its usual place below the head of the fibula. An attempt was made to locate its ends, but they were not easily found, and prolonged search was not made. It was thought wise to first gain healing of the wound and then make secondary suture of the nerve. The wound healed in part by primary union, in part by granulation. June 27 it was closed, and on that day nerve transplantation was done as follows:

Ether. Esmarch's bandage. Seven-inch incision at outer aspect of knee. Scar tissue removed. The lower end of the upper fragment of the external popliteal nerve was found without difficulty. It was bulbous. Considerable time was spent in searching for the lower fragment, the peroneus longus muscle being fully exposed. An incision was made in front of the

fibula and the anterior tibial nerve was found lying on the extensor longus digitorum. This nerve was traced upward and the external popliteal discovered, its bulbous end being about one-third of an inch above the division of the nerve into the anterior tibial and musculocutaneous. Both bulbous ends were pared; about three and one-quarter inches of space intervened.

During this work, my colleague, Dr. Freeman, had kindly exposed the great sciatic nerve of a thirty-five pound dog. A fragment four inches long was removed, passed between the peroneus longus and the fibula of the patient, and implanted in the external popliteal. Three sutures of fine chromicized catgut were used at each end, one suture being passed through the nerve substance, the other two uniting the sheaths. The fragment was slack and the ends lay in perfect approximation. The external wound was sewn without drainage, the knee placed at an angle of 135°, and a large aseptic dressing with plaster-of-Paris splint applied. Primary union. The knee was confined for a month.

Just before operation, the patient was examined by Dr. J. T. Eskridge, neurologist to the hospital, who reported anæsthesia of the skin area, supplied by the external popliteal nerve together with complete paralysis of its muscles. According to notes made at the time, Dr. Eskridge examined him again on July 20, saying that the anæsthetic area remained about the same as before the operation. August 4 he says, "Temperature, pressure, pain sensations, and ability to recognize cold substances have returned over the entire anæsthetic area. Tactile and localization sensations and ability to recognize warm substances are a little impaired. All forms of sensation are delayed." Under date of August 11 he says, "All forms of sensation normal." On August 13 Dr. Eskridge reported that the tibialis anticus and peroneus longus would not respond to the strongest faradic current.

At this time the patient left for his home in Michigan. I did not hear of him again until April of the following year, at which time Dr. Reuben Peterson kindly examined him, and reported as follows under date of April 3, 1897:

"Patient can feel the touch of a pencil over the entire leg and foot, but sensation is somewhat diminished over an area three or four inches long by a couple of inches wide at the external part of the lower third of the leg, and on the internal aspect

of the instep down to the scar made by the removal of the great toe. There is considerable atrophy of the muscles of the leg in the upper third. Circumference of the right leg, eleven inches; left, twelve inches. Middle of calf, twelve inches on the left leg; eleven inches on the right leg. Upper third, right, seven and three-quarters inches; left, eight and one-quarter inches. Abduction of foot impossible. No movement of toes except those controlled by extensor tendons. First and second toes somewhat contracted. Unable to hold foot up. Has good movement in walking, except that he has to lift right leg higher than the other to keep the toes from dragging. I should say that the result is good as far as sensation is concerned, but negative as regards motion. The muscles fail to react to electricity." Another operation was at this time advised, but declined.

A further report on the case was courteously made by Dr. Richard R. Smith, of Grand Rapids, Michigan, August 31, 1903, seven years after operation. Dr. Smith writes as follows:

"There is a very decided atrophy of the anterior muscles of the leg. The patient is unable to flex the tarsus upon the leg in the slightest degree, nor is he able to extend the phalanges of the toes. There is complete paralysis of the tibialis anticus, the extensor proprius pollicis, the extensor longus digitorum, the peroneus longus and brevis. There is partial anæsthesia over the area supplied by the peroneal nerve."

The end result in this case is, then, a complete failure as regards motion, and this in the face of conditions which seemed to promise a good result. The ends of the implanted fragment were carefully approximated, the sutures suitable, wound healing was perfect, and the fragment stayed in.

Summary of Twenty-two Cases of Nerve Grafting.—

1. Case dismissed too early to record result.
2. Implanted segment came away necrotic.
3. Case dismissed too early to record result.
4. Negative at end of one year.
5. Sensation began to return in two months. Motion not recorded.
6. Suppuration. No improvement at end of two months.
7. Sensation good at end of five weeks. Motion indefinitely recorded.

8. At end of ten weeks an indefinite result is recorded.

9. At end of two years sensation "dull;" motion fair.

10. Motion and sensation (median) practically restored at end of six years.

11. Case reported too soon (sixteen days).

12. At end of three months, ulnar. Sensation hardly complete. Motion indefinite.

13. At end of eight months. Motion fair. Sensation not noted.

14. Reported too soon to be of value (thirty-six hours).

15. Sensation returned (fifteen days?), but motion did not.

16. No result at end of two and three-quarters months.

17. No result at end of three years.

18. No improvement.

19. "Good" result at end of two years. (Median.) Sensation good; hand "lame but useful."

20. One and one-half years after operation (at end of four months patient froze hand, losing distal phalanges of first and third fingers). Sensation nearly normal. Hand used daily in work; fine movement of it impossible; some atrophy of muscles.*

21. Short time—leg had to be amputated—motion as well as sensation seemed to be returning. (Durante.)

22. Author's case. Reported at end of eight years. Failure.

As Peterson's paper is readily accessible, the reader is referred to it for details. The writer has added to the twenty cases there recorded that of Durante and his own. These seem to give three "good" results (Cases 10, 19, 20) and three which may be termed "fair" (Cases 9, 13, 21). Twenty-two per cent. of the cases operated on may be said to have terminated in a satisfactory way, although in most of these the final result is not recorded with the detailed accuracy desired by one who

* A recent letter from Dr. Peterson reports this patient as being at this time "perfectly well as regards the use of his hand."

would analyze them. One is forced to say that he questions the authenticity of some of the results accounted " satisfactory."

To this must be added the claims of various surgeons and experimenters that a piece of nerve has no intrinsic superiority as a graft to any other kind of organized tissue, and that given proper isolation of the divided ends from the surrounding tissue a bridge of any sort—a bundle of catgut loops for example—is sufficient to permit of the regeneration of the nerve.

The writer, in studying this branch of the subject, concludes that nerve transplantation should be discarded.

Flap Operations.—While several forms of neuroplasty have been proposed, the principle of all is the same, viz., a portion of the central or peripheral (or both) ends is partly detached, turned back, and united to the other end or flap. The principles underlying these operations, the technique, etc., have been fully described in text-books and monographs. (De Forest Willard.)

The writer herewith briefly recapitulates the cases found by him in literature.

1. Létiévant, the deviser of the operation, experienced failure in his only case in human surgery. (See Chipault's " Operative Surgery of the Nervous System," 1895.)

2. Dittel, another early operator, reported a failure (*ibid.*).

3. Wölfler (" Neugebauer, Neurorraphie u. Neurolyse," *Beiträge z. klin. Chirurgie*, xv, 1895) did a neuroplastic operation after injury to the radial; the patient shortly disappeared from view.

4. Tillmann's case reported in Chipault's " Operative Surgery of the Nervous System," neuroplasty of median and ulnar nerves, success.

5. Gleiss—same reference—successful neuroplasty of ulnar.

6. Brenner (*Wien. klin. Wochen.*, 1891). This case is remarkable in that operation was performed ten years after original injury. A flap operation was done upon the median nerve with a good ultimate result.

7. Bobrow (1893, cited by Spijarny, original journal inaccessible). Excision of tumor involving sciatic in elderly man. Flap operation. Return of sensation and of use of flexors of knee (?).

8. Giordano (*Clinica Chirurgica*, March, 1899). This surgeon, in removing a tumor of the neck, was obliged to resect four centimetres of the vagus, the defect being overcome by a flap operation. Patient lived a year. For a short time after the operation he coughed at times.*

* This case should really be discarded, for it is known that the vagus of one side may be resected with comparative safety.

9. Von Bruns (*Allegem. Zeitsch. f. Psychiatrie,* Band lii (1895-6). This surgeon operated upon an infant aged two months for congenital neurosarcoma of upper arm involving ulnar and median. No attempt to restore continuity of nerves until a year had elapsed, when, to overcome the paralysis, a flap operation was performed on both nerves. Under appropriate after-treatment there was an excellent return of function in the domain of the ulnar and a partial return in that of the median.

10, 11. The writer has not access to the cases of Lossen (Hueter-Lossen, Grundrisse d. Chirurgie, seventh edition, 1896) and Gundt (Inaug. Dissert., Berlin, 1897). He gathers the impression that these cases were successful.

Of these eleven cases five are discarded as having been reported too early or as lacking in detail. Of the remaining six, two were failures and four complete or partial successes.

Implantation or Anastomosis.—The ten cases in which defects in the continuity of nerves were overcome in part by anastomosis are as follows:

1. KENNEDY (Vol. ii of Chipault's "État actuel," etc.). In one case, Kennedy implanted the central ends of the median and ulnar into the radial. Result negative.

2. DESPRES (cited by Dumstrey) implanted an injured median into the ulnar and obtained a "fine result."

3. GUNN (cited by Dumstrey) sutured the distal end of the ulnar (after removing a neuroma) into the median. Sensation returned; no report as to motion.

4. SICK (cited by Dumstrey) sutured the radial to the median; eighteen months later there was an excellent result as to both motion and sensation.

5. NEUGEBAUER (sometimes quoted as Wölfler's case, cited by Dumstrey). After scar excision for contracture (bend of knee) peroneal paralysis was noticed. Anastomosis between the peroneal and (assumed) internal popliteal. Result negative eight months later.

6. DUMSTREY (*loc. cit.*) implanted the ulnar into the median and got partial return of motion and sensation.

7. TRZEBICKY (cited in Chipault's "État actuel," etc.) sutured both ends of external popliteal to internal popliteal. Result satisfactory.

8. TRZEBICKY (*v. supra*), after resecting median (?) for sarcoma, implanted central (?) end into ulnar. Result satisfactory.

9. TRZEBICKY (*v. supra*), after resecting the ulnar for sarcoma, implanted its central (?) end into the median. The primary result was satisfactory, but the patient soon died of metastases.

10. CODEVILLA (*Clinica Chirurgica,* 1900, Nos. 9, 10). In a case in which the outer side of the knee was crushed, with the peroneal nerve

involved in the scar, the peripheral end of the latter was grafted into the internal popliteal. No improvement followed.

The results may be considered encouraging in five or six cases out of the ten (fifty per cent.).

Resection of Bone.—Since it is a foregone conclusion that if a divided nerve can best be made to heal under favorable conditions of approximation, and that removal of a segment of long bone will permit this approximation and guarantee the restoration of nerve continuity, it will be seen that the only practical question involved is "when is it justifiable to resect bone for this purpose?" It is not easy to answer this. The writer has found notes of seven cases, in the majority of which the bones were injured in the original traumatism which involved the nerve. In one of Keen's two cases resection was undertaken for false-joint following fracture. The references are as follows:

Keen (two cases), in Chipault's "État actuel," etc.; Rose and Carless ("Text-Book on Surgery"), and the older cases cited by Huber and other systematic writers (Lewin, Löbker, Bergmann, Wheeler).

Suture à Distance.—This consists essentially of bridging a defect with loops of catgut, etc. The positive results of Glück and Ehrmann are sufficiently well known. Recently, Keen (in Chipault's "État actuel," etc.) has reported a case with negative result.

Tubulization.—Although this method is extensively quoted in literature, the writer is able to find but one case in which it has been used to favor the restoration of nerve continuity to the exclusion of other resources. To promote nerve regeneration along the natural paths, surgeons have made use of barriers to prevent the fusion of nerve substance with the surrounding tissues. This is recorded many times in cases of simple nerve suture. So far as it refers to the principal method of securing continuity, the writer knows only of the case of Guelliot; this is cited by Ehrmann and others. As it resulted negatively, he judges that the theoretical operation of van Lair has never assumed a definite status in practice.

General Conclusions.—Although correction of the evils resulting from a gap in the continuity of a nerve is a matter of great importance in a given case, it hardly seems possible at this time to say definitely what form of bridging should be employed. More cases, and especially cases recorded later and better, are needed. Neuroplasty and implantation (anastomosis) are always available resources, and for the present it would seem that they should be preferred. Resection of bone may be advisable in selected cases. Transplantation of foreign grafts should be abandoned. It is hardly necessary to say that prognosis in an individual case should always be guarded, and that repeated operations may be necessary.

TOTAL AVULSION OF THE SCALP.[1]

BY ERNEST J. MELLISH, M.D.,

OF EL PASO, TEXAS,

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At about six o'clock A.M., September 23, 1903, Mrs. E. L., aged thirty years, while grinding grain with a belt machine, was caught by her hair (which was not hanging loose) by the perpendicular belt and was hoisted to the low ceiling and then dropped to the floor, leaving the entire scalp, together with all of the left ear, excepting the tragus, the antitragus, and the lobule, and all of the integument and subcutaneous tissue down to the fifth cervical spine behind and to the zygoma and bridge of the nose in front, dangling from the shaft. About half of the left lid and a portion of the right were pulled off with the scalp. A layer of the left temporal muscle was gone, and the cranial bones were denuded of periosteum in several places.

Dr. J. A. Samaniego saw the patient a few minutes after the accident and immediately applied a bichloride-of-mercury dressing. There was scarcely any bleeding and but little apparent shock. I saw her three hours after the accident, but did nothing except to recommend her removal to the hospital, which she entered the same day.

On the second day, twenty-six hours after the injury, shaving grafts (Thiersch) from the patient's thigh were transplanted to the lids and forehead up to the frontal eminences.

September 26, fourth day, grafts from the opposite thigh were placed on both temporal regions, on the mastoid regions, and on the neck for a width of six centimetres (two and one-half inches).

September 28, sixth day, a broad strip around the head was grafted from the husband's thigh. At this time a surface of about 180 square centimetres (seventy square inches), representing approximately half of the denuded area, had been covered with grafts.

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[1] Read before the New Mexico Medical Society, May 11, 1904.

September 30, eighth day, a large surface was grafted, partly from the patient's thigh and partly from that of the husband. At the same time a large superficial slough was excised from the vertex.

October 5, thirteenth day, the remainder of the denuded surface was grafted from the thigh of a fourteen-year-old boy. At this time all of the surface was covered with epithelium excepting a few small areas of denuded bone and some spots of granulations between the edges of the grafts.

October 13, twenty-first day, all grafts were looking well, the entire surface where it was denuded being covered with movable skin, excepting the areas of denuded bone. These bone areas were already nearly covered with granulations. Thinking that the moist boric-acid dressings, which had been used up to this time, might cause too much maceration, I dusted the head lightly with boric-acid powder and applied a little carbolated vaseline instead. At the next dressing, two days later, I found that the vaseline dressing was macerating the new skin, so discarded it and applied a physiologic salt solution dressing. On the second day after this there was pus on the surface of the grafts, the amount being much larger on the grafts taken from the man and boy than on the ones autotransplanted. From this time on to the fortieth day from the time of the injury the grafts from the man and boy gradually dissolved off, despite all treatment applied. It was a molecular disintegration from the edges of the grafts. All of the autotransplanted grafts remained intact, and it is noteworthy that several of them formed islands, around which grafts from the other persons had been placed.

November 5, forty-third day, a large area was grafted from the patient's leg, and on the forty-eighth day the grafting was finished from her arm.

Sixty days after the injury the entire area which had been denuded was covered with movable skin, with the exception of three spots, the largest three centimetres in diameter, where a little of the bone was still bare. These soon cicatrized. (Figs. 1 and 2.)

The highest temperature (mouth) of the patient during treatment was 101° F., and the highest pulse-rate 116, on the second day. The temperature ranged from 99° to 100° F. up to the thirtieth day, after which it remained normal.

The above history tells only half the tale. Having gotten a denuded cranium completely covered with new skin, the next part of the battle is to prevent loss of considerable portions of the new skin from pressure or from microbic invasion. The pressure of the dressings across the forehead while the vertex was still under treatment, although the dressings were elastic and were carefully applied, caused a slight exfoliation of the stratum corneum, and microbic action carried the process through the still feebly resistant skin; but it healed readily, leaving a movable cicatrix.

After complete healing of the entire surface grafted, although the head was kept covered with a layer of absorbent cotton, held on with a muslin skull-cap, the stratum corneum would give way here and there, small crusts would form, and in a very short time thin seropus would lift the corneum and lucidum from the rete over a large area. Close attention prevented destruction of the deep layers so extensively as to require regrafting. If vaseline or lanolin were applied too freely the stratum corneum also gave way. Then, too, it was necessary to avoid the use of any but the mildest antiseptics, either in the form of powder or otherwise, when ulceration occurred. Since May there has been no further trouble. The patient wears a wig of her own hair. (Fig. 3.)

None but the Thiersch grafts were used in this case, because I considered this to be the best form of graft for the purpose. The grafts were about two and one-half centimetres (one inch) wide and from five to twenty centimetres (two to eight inches) long. For the skull I made the grafts rather thick, including, besides the stratum corneum, the stratum lucidum and the stratum Malpighii or rete mucosum, with the tips of the papillæ of the chorium, also a considerable portion of the chorium proper. The edges of the grafts should overlap slightly.

The surface from which the grafts are taken is shaved, scrubbed with alcohol, and then anæsthetized by the application of a mixture of ice and salt. Occasionally, the skin was frozen stiff, but not intentionally so, as a sufficient degree

FIG. 1.—Result from skin-grafting in case of avulsion of scalp. (Lateral view.)

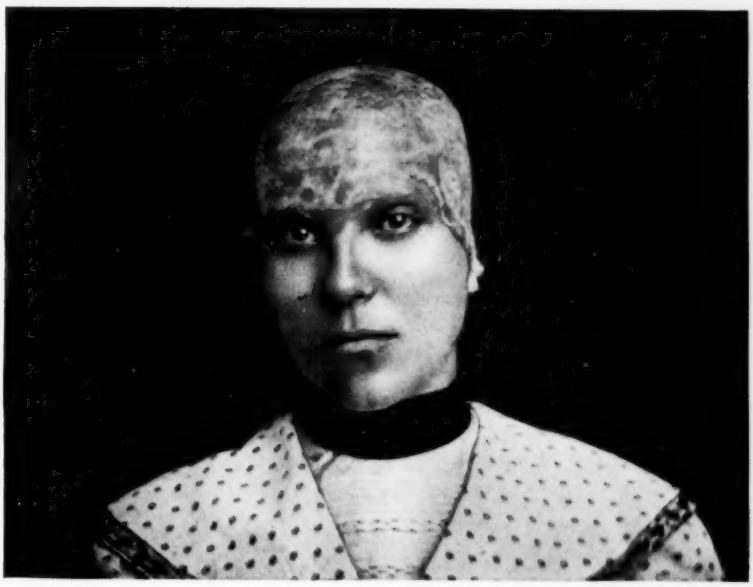

FIG. 2.—Result from skin-grafting in case of avulsion of scalp. (Anterior view.)

FIG. 3.—Final result in case of avulsion of scalp; cicatrized area covered by wig.

of anæsthesia can be obtained short of freezing. The freezing seemed to make no difference in the vitality of the grafts, as none were lost primarily. The same hollow-ground razor used for shaving was, after cleansing with an alcohol sponge, employed to cut the grafts. No special knife is needed for this purpose. If the assistant holds the skin taut with a hand laid flat on each side of the limb, the graft can be cut in less time than it takes to write this sentence. The skin is wiped dry with a sterile gauze sponge, the razor dipped in physiologic salt solution, and the graft cut with a sawing motion.

Of course, grafts are always placed on an aseptic surface, either freshly denuded or granulating. Not many years since, it was thought that skin-grafts would grow only on a granulating surface. It is now well known that they will grow readily on raw aponeurotic surface and on raw bone.

In this case, as indicated in the clinical history, only grafts from the patient herself produced permanent skin, although none of the heterogeneous grafts were lost primarily. Bivings, quoted below, had a similar experience in his case. We must, then, conclude that heterogeneous grafting on the vault of the cranium should be avoided.

Complete avulsion of the scalp is sometimes attended with fatal hæmorrhage and shock, and the next danger is from infection, often resulting in death from sinusitis, meningitis, cerebritis, erysipelas, or long-continued suppuration. These conditions are, as a rule, avoidable.

I find nothing of account on the subject of avulsion of the scalp in any of the standard text- or reference-books. The only article in a goodly line of current literature at my disposal is one by W. Troy Bivings, of New York, entitled, "Avulsion of the Scalp, With Report of a Case" (*Philadelphia Medical Journal*, Vol. ix, p. 1020, June 7, 1902).

A noteworthy feature in all of the cases reported up to the time of Bivings's publication is the length of time required for the treatment. In one of Gussenbauer's cases, it required twenty months to effect complete healing, owing to the continual breaking down of the cicatrices. In this case 340 pieces

of skin were grafted, 270 of which healed in place. In another of his cases of complete avulsion, in a girl of sixteen years, death resulted a few days less than a year after the injury. Abbe, of New York, reported a case in which 12,000 grafts were planted in four years. In the winter of 1892–3, the late F. C. Schaefer exhibited a case before the Chicago Medical Society which, to the best of my recollection, had been under treatment for at least one or two years and was not yet healed. In the case reported by Bivings, in which approximately half the scalp was avulsed, healing was complete in about eighty days from the time of injury,—marking, apparently, a distinct advance in the management of such cases. The case here reported, involving the entire scalp, was completely healed in seventy to seventy-five days, and this time could have been reduced by about half through avoiding the use of heterogeneous grafts. Practically, the entire head was covered with new skin within three weeks after the injury, but the heterogeneous part of it disintegrated during the next three weeks.

As a matter of historic interest, I will quote from Bivings's article the following:

"In consulting the literature on this subject, I have been fortunate enough to discover an article entitled, 'Remarks on the Management of Scalped Head,' by the late Felix Robertson, M.D., which was published in the *Philadelphia Medical and Physical Journal* years ago, from which I quote the following:

"'In the year 1777, Fred Calvit was badly wounded and nearly the whole of his head skinned. Dr. Vance of the Long Islands, of Holsteins, was sent for and stayed several days with him. The skull bone was quite rotted and began to turn black in places, and, as Dr. Vance was about to leave Calvit, he directed me (as I was stationed in the same fort with him) to bore his skull as it got black, and he bored a few holes himself to show the manner of doing it. I have found that a flat-pointed, straight (shoemaker's) awl is the best instrument to bore with, as the skull is thick and somewhat difficult to penetrate. When the awl is nearly through, the instrument should be more lightly borne upon. The time to quit boring is when a reddish fluid appears on the point of the awl. I bore at first about one inch apart, and as the flesh appeared to rise in these holes I bored a number more between the first. The flesh will rise considerably above the skull and sometimes raise a black scale from it, about the thickness of common writing-paper. It is well to assist in getting off the scales of bone with the awl. These scales are often as large as a dollar, sometimes

even twice as large. It will take at most two weeks from the time of boring for it to scale. When the scale is taken off at the proper time, all beneath it will appear flesh, like what we call proud flesh, as if there was no bone under it. The scalped head cures very slowly, and if this kind of flesh rises in places higher than common, touch it with blue-stone water and dress it once or twice a day, putting a coat of lint over it every time you dress it, with a narrow plate of ointment. It skins over remarkably slow.'

"'In 1768, I saw a young man in South Carolina, who had been scalped eight years before that time, and about twice the size of a dollar of the bone of his head was perfectly bare, dry, and black. I am persuaded that, had his skull even then been bored, he might have recovered of the wound, which put an end to his life about a year after I saw him. The naked portion of the bone rotted or mortified and exposed the substance of his brain, a very considerable quantity of which issued out at the opening at his death.'"

Bivings reports that after careful and systematic research he was unable to find more than thirteen cases of scalp avulsion recorded, and several of these were incomplete in character, in so far as the scalp was only partially destroyed. "Of the thirteen cases, one case was reported by Hyrtl, two by Gussenbauer, two by Robertson, one by Sutliff, one by Warren (J. C.), one by Warren (J. M.), one by Lucas, one by Gerok (M.), one by Abbe, one by Sick, one case (under treatment) in Gouverneur Hospital."

Bivings's case in brief. Girl aged fourteen years, white. Injury, October 24, complete avulsion of the scalp, together with the periosteum, covering both the parietal and a part of the occipital bones. Unconscious when first seen; marked concussion; some hæmorrhage from branches of temporal, posterior, auricular, and occipital arteries. Wound surface dirty and greasy. Thorough cleansing, bichloride applied, then a wet dressing of aluminum acetate; ice helmet. Bones exfoliated in about two weeks. The latter part of November a bilateral bronchopneumonia had developed from pertussis, which she had at time of injury; patient very ill for five days; temperature, 105.5° F. Three skin-grafting operations, the last one on January 1. First grafting from father's thigh, grafts one by three inches in size. They were Thiersch grafts and the majority of them grew. Second operation was a combination of the Krause and Reverdin methods; skin taken from thighs of eighteen-year-old boy; none grew. Next tried egg skin and frog skin, and Lusk's method; all failed. Patient then had bilateral mumps, followed by membranous colitis; very ill. Third operation, January 1; Thiersch grafts from patient's thighs, flabby granulations having been curetted away four days previously. Two weeks later head entirely covered with skin.

TRAUMATIC ABSCESS OF CEREBRUM.

RECOVERY AFTER TREPHINING AND DRAINAGE.

BY ERNEST F. ROBINSON, M.D.,

OF KANSAS CITY, MISSOURI.

THE following case of brain abscess is reported because of its interesting diagnostic features, and also because it illustrates to what an extent operative interference may be carried in dealing with brain tissue itself, provided the principles of asepsis are followed.

Temporosphenoidal Abscess following Gunshot Wound of Ear; Trephining; Drainage with Rubber Tube for Three Days; Recovery Complete, without Paralysis or Loss of Cerebral Function.

May 10, 1904, Mrs. M., twenty-eight years old, a slender German woman, during a period of mental depression shot herself with a 32-caliber revolver in the right ear. Four days after the injury she was seen in consultation with her attending physician, Dr. Barnett, of Rosedale. She had reacted fairly well from shock, but lay in a semiconscious condition. The wound just behind the right external auditory meatus was badly powder-burnt, but had suppurated very little. Under chloroform anæsthesia the ear was thrown forward by a curved posterior incision and a badly battered 32-caliber bullet, together with fragments of lead and bone, removed. The bullet had shattered the petrous portion of the temporal bone; only a thin shell of bone remained between this cavity and the cerebral contents. The wound was cleansed, packed through the bullet wound, and the incision closed with sutures. There was paralysis of the right side of the face and inability to completely close the right eyelids, due to injury to the seventh nerve. The operative wound healed by primary union, and the gunshot wound was clean and had almost closed when the patient was turned over to attending physician.

Six weeks after the injury, June 23, 1904, I again saw the

patient, owing to some unusual symptoms that had recently developed. She was seated in a chair by the bedside, with one hand against the right side of her head. Her physician stated that she would remain in the same position for hours, or when put to bed would lie in one position, usually on her side, without moving. When aroused she complained of frightful headache, chiefly over the right side of head, forehead, and right eye.

Her mental faculties were decidedly dulled. When spoken to she would be slow in replying, often waiting so long that it was thought she had not heard or comprehended, when suddenly she would answer shortly but correctly. A long reply she would not make, and often she would not reply at all, even to a simple question, apparently going off into a doze. Sometimes she would not finish her sentences; all her mental processes seemed dulled or delayed, and she had not the power of sustained attention. She was mildly delirious at times. Her temperature was subnormal, and her pulse was slow but weak at 52 per minute.

The pupils were markedly unequal; the right dilated but reacted slowly to light. Nystagmus was present. No changes in the fundus could be detected. The patient had vomited several times recently, but there was no persistence of this symptom, and it was difficult to determine that it was of central origin. The tongue was coated and the breath foul. The tongue deviated markedly to the left side. There was no paralysis beyond that of the seventh nerve, which had been destroyed by the original gunshot wound. The patient was extremely weak. She voided urine normally, but was habitually constipated. There had never been any rigors or convulsions, but emaciation was extreme.

It seemed probable that an abscess of the temporosphenoidal lobe had developed, either through an infection which had extended from the old gunshot wound, or (which seemed more probable, considering the clean conditions of the wound) that the severe local concussion which the temporal lobe had received at the time the shot was fired had so devitalized an area of brain substances that a local abscess resulted. This latter opinion was found correct.

Patient was immediately sent to St. Joseph's Hospital, where, with the assistance of Dr. Barnett and Dr. C. L. Spaulding, the skull was opened. An inverted U-shaped incision was made, beginning at the angle of the mastoid, extending upward for

about two and one-half inches, and then curving forward and downward to a point three-fourths of an inch anterior to the middle of the zygoma. The bone was laid bare, hæmorrhage was checked, and a trephine placed one inch above and anterior to the external auditory meatus. This afforded access to the sphenotemporal lobe at its base, and was admirable for exploration and drainage. The trephine opening was slightly enlarged with rongeur forceps, and a meningeal vessel of fair size was ligated with catgut on a fine curved needle. The meninges were opened, when the brain bulged into the wound, but did not pulsate. Its surface was normal. A large, smooth bullet probe and, later, a grooved director were passed under the temporal lobe, and also between the meninges and the bone, but failed to find pus.

Consequently, a medium sized aspirating needle was thrust into the brain substances downward and forward towards the petrous bone. At a depth of about one inch it encountered pus. The needle was left *in situ* and a grooved director was passed along it as a guide, and about two drachms of pure yellowish pus were evacuated. A small rubber drainage tube was inserted most carefully into the brain substances down to the point where pus was encountered. There was no distinct abscess wall. The free end of the tube was brought out through a button-hole in the skin flap. The brain substances were injured almost none at all.

The wound was closed, and a small wick of gauze was inserted at the posterior angle of the wound down to the meninges. There was very little shock. Patient left the table with a pulse of 60 and of fair quality. Morphine was given, and she had a very comfortable night. She was not nauseated. The following morning she was conscious, and asked about her husband and doctor, and specified the kind of food she wanted. Pulse, 66; temperature, 99° F.

During the day she lay quiet, but could be aroused. At these intervals she seemed conscious. Her condition remained practically unchanged until the third day, when her mental stupor deepened and symptoms of cerebral pressure developed.

The wound was immediately dressed. The drainage tube (which had ceased discharging) was removed, and the track of the tube gently irrigated with sterile water. The wound was

perfectly clean. The next morning the patient was conscious. She talked rationally to her nurse, and was reading a German prayer-book when visited by the house doctor. The tube was evidently causing the pressure symptoms. From this on she made an uneventful and rapid recovery.

An interesting psychological point in reference to her convalescence is the fact that the patient remembered nothing that occurred from the date the injury was received until a few days prior to her departure from the hospital.

On July 5 she returned home without a single mental symptom. Her further progress towards recovery was uninterrupted.

FRACTURE OF THE BASE OF THE SKULL.

A CONTRIBUTION BASED ON THE CLINICAL AND PATHOLOGICAL RECORDS OF FIFTY CASES.

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THIS study has received fresh impetus from the recent work of Rawling (*Lancet*, April 9, 16, 23, 1904), who devotes special attention to the course followed by lines of basal fracture, and gives certain rules which he states will in the great majority of cases be found to be correct, though exceptions may occur. The accompanying diagrams represent approximately the lines indicated by this author. (Fig. 1.)

Among other points of interest in Rawling's communication may be mentioned the following: The sella Turcica was implicated in 70 per cent. of cases; the line of fracture is extremely liable to follow a suture, either causing its separation or cutting across its irregularities; Battle's view that lines of fracture are apt to cease at foramina is erroneous, as well as the idea that the optic foramen is extremely liable to implication; profuse and persistent bleeding from the ear is sufficiently indicative of middle meningeal hæmorrhage to suggest operation over this artery without other sign of its rupture.

These views are in some ways diametrically opposed to those usually accepted; for example, the general consensus of opinion regarding the lines of fracture, apart from the statement that a few general directions are followed, is thus expressed in Dennis' "System of Surgery," "At all events, the majority of basal fractures follow no predetermined rule."

With the view of contributing a number of consecutive observations towards the settlement of this question, as well as of studying other points of interest, I have gone over the autopsy reports of fifty cases of basal fracture, through the

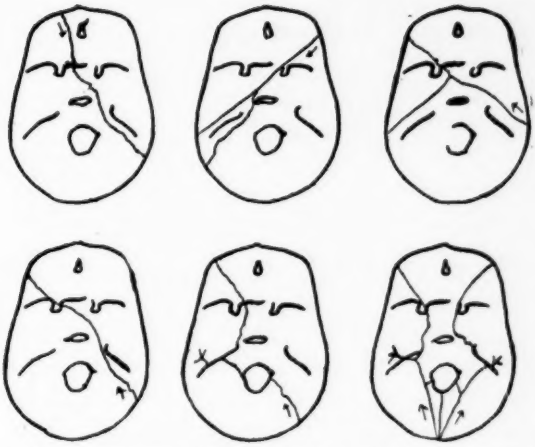

FIG. 1.—An approximate representation of Rawling's lines of fracture resulting from impacts of various directions.

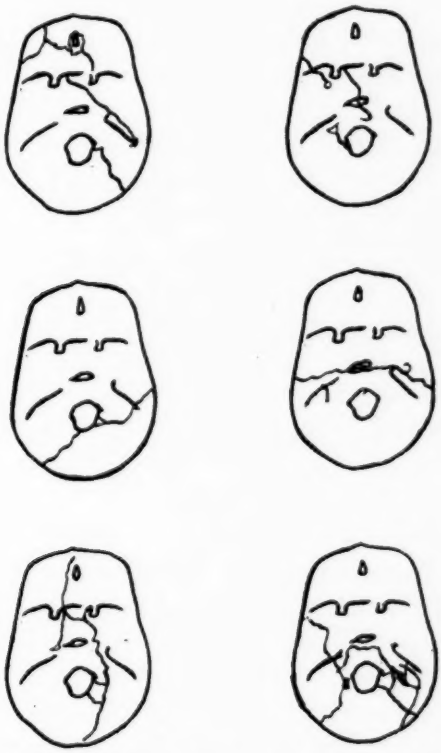

FIG. 2.—Approximate representation of von Wahl's bursting fractures as pictured in Dennis' "System of Surgery."

courtesy of Dr. Wright, pathologist at the Massachusetts General Hospital, and of Dr. Mallory, pathologist at the Boston City Hospital. Diagrams of all are submitted. It is not claimed that the exact course of each fracture is pictured, but the lines of fracture were in general so carefully recorded as to be susceptible of fairly accurate diagrammatic representation, excepting in minor particulars. In one case, that in which all the fossæ were invaded (Fig. 12), the statement was made that the fracture on the left was in the shape of a C, beginning in the occipital and ending in the orbital fossa, without indicating its exact course from one to the other; in this instance, therefore, the course of fracture should not be regarded as at all accurately represented except in its limits.

A word will be in place regarding the method of production of basal fracture. The view held by earlier writers that fractures of the base resulted from *contre-coup* was displaced by the irradiation theory of Aran (*Arch. gén. de Méd.*, 4th Series, T. vi, p. 180) (fortified by Hewitt, Bergmann, and others), who established the fact that in case of fracture resulting from a blow upon the vault the line of fracture tends to enter the nearest fossa, and that it is impossible experimentally to produce fracture by *contre-coup*. This view now generally obtains, with the modification that lines of least resistance are followed, as first suggested by Félizet, rather than the shortest anatomical route as maintained by Aran. The so-called bursting fracture of Hare (*Lancet*, February 4, 1888), Messerer, Hermann, and von Wahl presupposes a pressure upon the side of the skull producing a fracture of the base, much as pressure on the opposite poles of a spherical body causes it to burst across its equator. (Fig. 2.)

Rawling explains the so-called bursting fractures at the base by a modification of the irradiation theory. According to his view, if a man receives a violent impact on the back of the head, the force, though greatest at the point of impact, may be insufficient to overcome the resistance of the occipital bone in this region, and yet, when transmitted to the more delicate bones of the base, prove sufficient to cause their fracture.

Probably both these principles come into play upon the complicated structures of the skull under the various conditions of impact against bodies of various sizes and shapes. A few primitive experiments will serve to show that the question is not simple even when applied to fairly uniform bodies subjected to various forms of trauma.

If an orange is squeezed between the palms until it gives way, the crack appears across the equatorial line midway between the hands, and extends in both directions. This result is constant in whatever position the orange is held, thus eliminating, or even overcoming, the influence of grain. (Figs. 3 and 4.) This illustrates the bursting fracture. If, however, the orange is suspended in the air, or laid upon the table and struck a violent blow on one side with a stick, it breaks at the point of impact and shows no evidence of bursting force; again, if a watermelon is laid on the ground and struck on its side, it gives way at the point of impact, and a crack extends from this point in the same direction. In other words, the region last to give way under steady compression between two forces is the first to give way under a blow.

If, now, instead of suspending the orange we impale it upon a stick, thus weakening one portion of the rind, and strike its side upon the floor, a crack is likely to appear at the point where the rind is perforated by the stick. This might suggest force transmitted from the point of impact to the weakest part rather than bursting force; but if we drop an orange to the ground, a bursting crack is apt to appear at the equatorial line, or between the point of impact and the equatorial line, on one or both sides, without fracture at the point of impact; or again, if we drop a watermelon to the ground, a crack, suggestive of bursting force, appears across its equator as well as depression of the region of impact and radiating cracks about this region. In the case of the watermelon the crack tends to go around the end, apparently the line of least resistance. A tendency to bursting fracture is present then, when the body, after swiftly moving, is suddenly brought to a standstill, though no such tendency appeared when it was hang-

FIG. 3.—Simple illustration of bursting fracture.

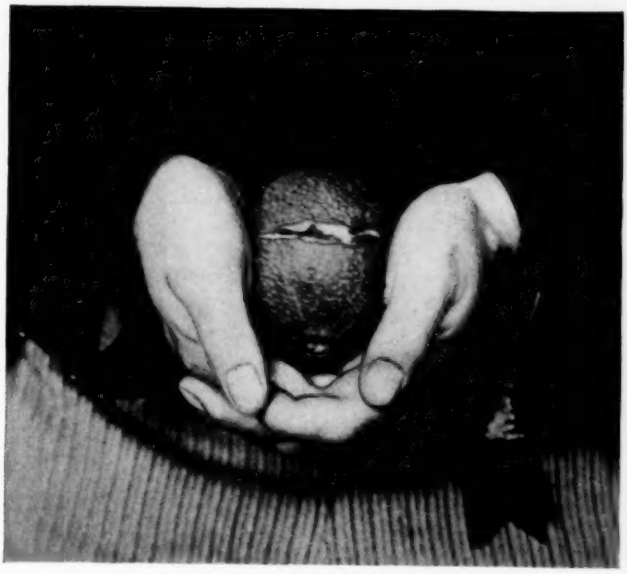

FIG. 4.—Simple illustration of bursting fracture.

ing quietly, and the implement of trauma was moving swiftly. This is doubtless because the momentum of the falling body causes its upper portion to act as a counter-compressant. The bursting principle, as well as the principle of transmitted force, may, then, have played a part in the case of the orange impaled upon the stick and struck upon the floor.

These simple experiments suggest that it is important to distinguish between falls on the head and blows upon the head from weapons, as well as to distinguish between both these conditions and a gradual pressure upon both sides of the skull.

These experiments, though suggestive, are introduced not with an idea that the structure of the skull and the conditions of actual trauma are even approximated, but with a view of illustrating the difficulties of the question with regard to objects of simplest structure subjected to the simplest forms of trauma, and to warn against too readily accepting any single explanation for the complex conditions found in basal fracture.

The following case, for which I am indebted to Dr. Wolberg, tends to show that even when compression occurs, if we have at the same time to do with a sharp blow from one of the compressing surfaces, especially if this surface offers a projection, the signs of greatest violence may occur at the point of impact. It also introduces another factor, namely, the age of the individual.

CASE.—A boy of about twelve jumped upon a rapidly moving hand-car. His head was caught between the cross-bar of the working-beam and the edge, or corner, of a tool-box. The result was a depressed fracture of the frontal bone, which rested on the tool-box.

Experiments on the cadaver promise little towards solving this problem. The question in dispute is not what occurs when the skull is subjected to violence, but what mechanical principles underlie the phenomena, of which we have already more evidence than we can analyze. Perhaps the following would be a reasonable working hypothesis: When the trauma results from (1) pure compression, the bursting principle alone, or at

least predominantly, underlies the fracture; (2) from a sharp blow, the violence is greatest at the point of impact and the transmission principle predominates; (3) from a fall, both factors take part. Between these three forms of trauma, *i.e.*, compression, blow, and fall, many gradations may occur, complicated still further by the character of the object causing impact and the age of the individual.

Possibly the addition of bursting force to the danger may partly explain the prevalence of falls over blows in the etiology of basal fracture, as illustrated by Graf's cases, in which sixty-three out of ninety resulted from falls.

FIFTY CASES.

The study of these fifty cases confirms the statement of Rawling that the impact is oftenest received in the basal plane, whether on the frontal or occipital region or upon the side of the head. There was no suggestion of the *contre-coup* of early writers. In fact, in the four cases resulting from blows on the vertex the line of fracture was continuous from the vertex to the base. When the line of fracture extended from any part of the vault, it generally entered the nearest fossa and extended in the direction of the force applied.

In twenty-two of the fifty cases, as will be seen from the appended diagrams, the lines of fracture either followed or suggested the lines of Rawling, as well as von Wahl's lines of bursting force, and fall almost invariably between the natural buttresses of the skull, indicated by various anatomists, extending from the vault to the base in the mid-frontal, external angular, mastoid, and occipital regions.

These results tend, therefore, to support the statement that basal fractures are prone to follow lines of least resistance.

The diagrams of the other twenty-eight cases, however, show results so variable as to make it plain that the exceptions to Rawling's lines, far from being occasional, are in the majority.

The sella Turcica was found a frequent seat of fracture, being implicated in eighteen cases (36 per cent.) from force

applied in all directions. The petro-occipital and masto-occipital sutures were also frequently involved, oftenest from violence in the mastoid region. The petrous portion of the temporal bone furnished a very frequent seat for fracture, generally in the transverse direction through the region occupied by the aural mechanism. This bone was fractured transversely twelve times, longitudinally four times. There was no example of the fracture, described by Rawling as a common form of middle fossa fracture, running through the external auditory canal on its way to the sphenoidal sinus, though there were several in which the fracture ran parallel with and anterior to the petrous portion. Nor was there corroboration of the observations of Honel (quoted by Dennis), that in seventeen out of the twenty-one cases of transverse fracture from blows on the side of the head the petrous portion was traversed longitudinally.

The orbital fossa was fractured in fourteen cases, five times from direct frontal violence, eight times from external angular or temporal violence, once from mastoid violence, in no case from occipital violence. The occipital fossa was implicated sixteen times, twice from frontal violence; the middle fossa ten times. There were seven instances (14 per cent.) of fracture limited to the base, two following blows on the vault in the horizontal plane, and two from unknown violence. In the five cases in which the direction of the violence was known, the line of fracture was generally in the same direction.

Comparisons of frequency of fossa implication with the records of Hewitt and Bergmann are as follows:

Anterior fossa alone, 0 per cent.; Hewitt and Bergmann, 12 per cent.
Middle fossa alone, 20 per cent.; Hewitt and Bergmann, 43 per cent.
Occipital fossa alone, 16 per cent.; Hewitt and Bergmann, 15 per cent.
Two or more fossæ, 64 per cent.; Hewitt and Bergmann, 30 per cent.

In studying these records, one finding impressed itself upon me which, so far as I am aware, has not been specially noted, namely, the frequent disintegration of brain tissue on the under surface of the frontal lobes posteriorly, and the under surface of the temporosphenoidal lobes anteriorly, that is, the

region bordering on the fissure of Sylvius. (Fig. 5.) This can only be due, it seems to me, to the impact of these regions against the lesser wing of the sphenoid bone, which fits into the fissure of Sylvius and separates these lobes.

Subconjunctival hæmorrhage led in one case to a diagnosis of basal fracture, not confirmed by autopsy. This will serve to remind us that subconjunctival hæmorrhage is not an infallible sign of fracture other than fracture of the outer wall of the orbit.

Regarding the direction of the blow in these instances, the only data to guide me were the statements of witnesses found in the clinical records, and the marks of external violence as recorded either in the clinical or the post-mortem records, or both. It is not claimed, therefore, that the conclusion arrived at regarding the direction of the blow was in all cases accurate; in fact, it is manifestly difficult and often impossible to determine the exact direction in which the skull receives the impact, even though the seat of the blow may be easily approximated. The appearance of various contusions in the same case may even prevent deciding upon the seat of the violence which caused the fracture. I was surprised to find several cases in which it was recorded that no external sign was found either by the clinical or the pathological examiner. There is a prevailing impression that this state of affairs is very rare, and results only from the use of some such instrument as the sand-bag.

The study of the cases in which the direction of the violence was known, together with that of other cases on record, enables us to judge the probable direction in the other cases, for it seems that the general direction of the fracture is that of the violence. This knowledge may prove of assistance in medicolegal inquiry, even though its clinical application may be limited.

In eleven cases the line of fracture was definitely stated to cease at a foramen; those mentioned were the foramen magnum, the jugular foramen, the foramen rotundum, the foramen ovale, the foramen spinosum, and the anterior condyloid foramen.

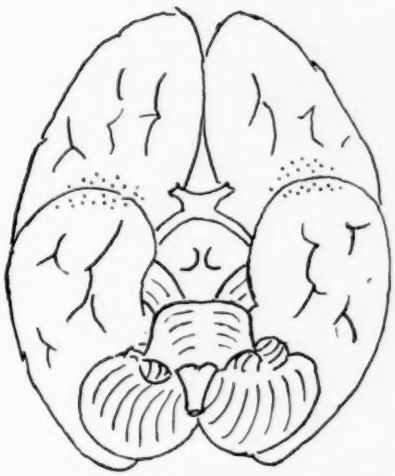

FIG. 5.—The dots show region of frequent disintegration of brain substance, due probably to impact against wing of sphenoid bone.

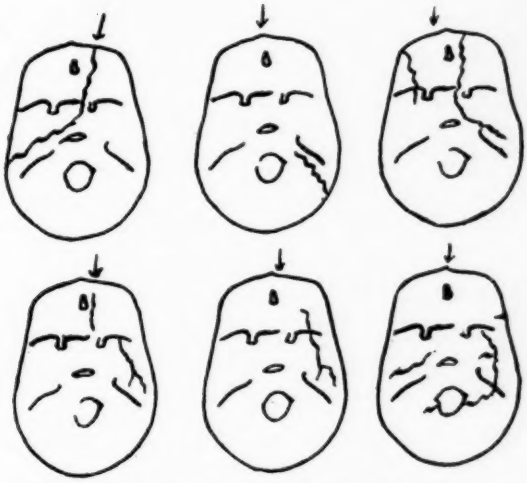

FIG. 6.—Lines of fracture resulting from frontal violence.

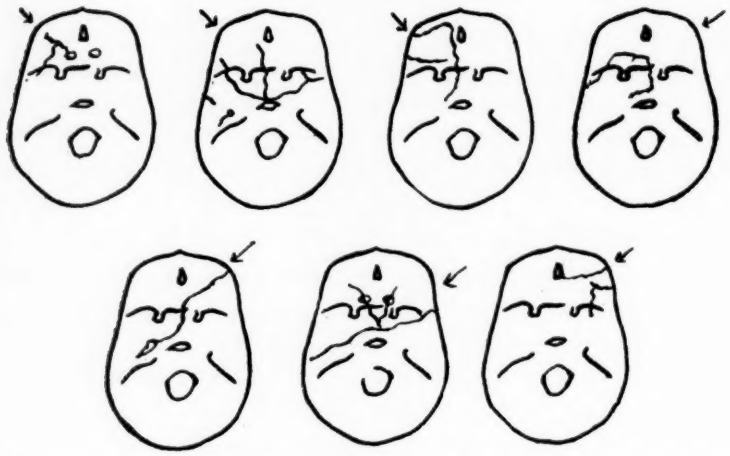

FIG. 7.—Lines of fracture resulting from violence in region of external angular process of frontal bone.

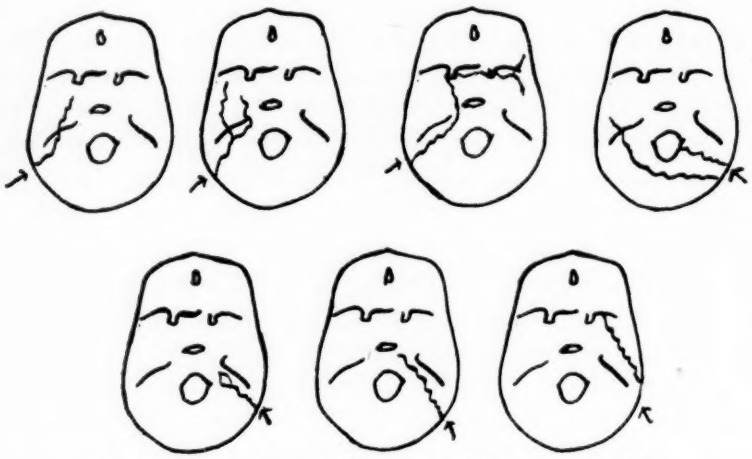

FIG. 8.—Lines of fracture resulting from violence in mastoid region.

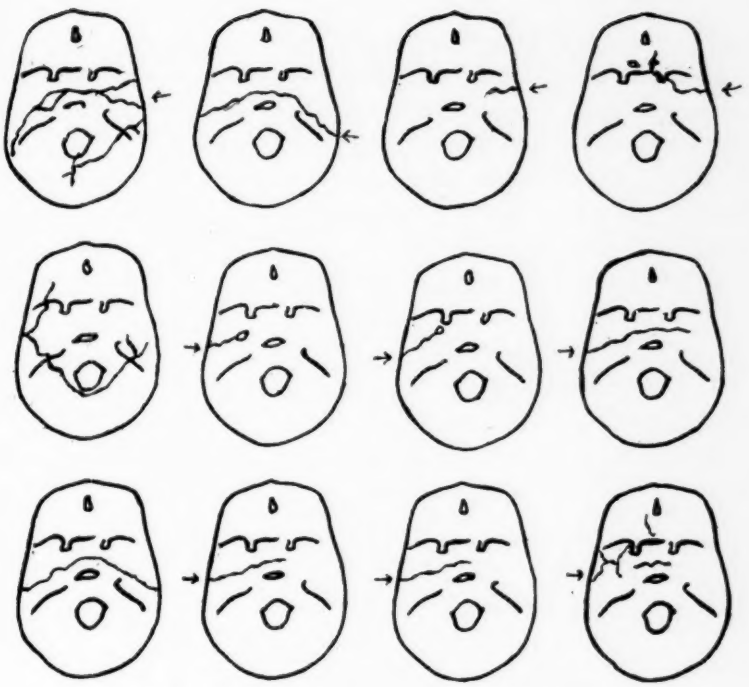

FIG. 9.—Lines of fracture resulting from lateral violence.

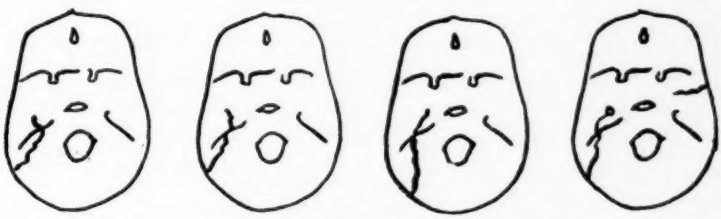

FIG. 10.—Lines of fracture resulting from blows in median line of vault.

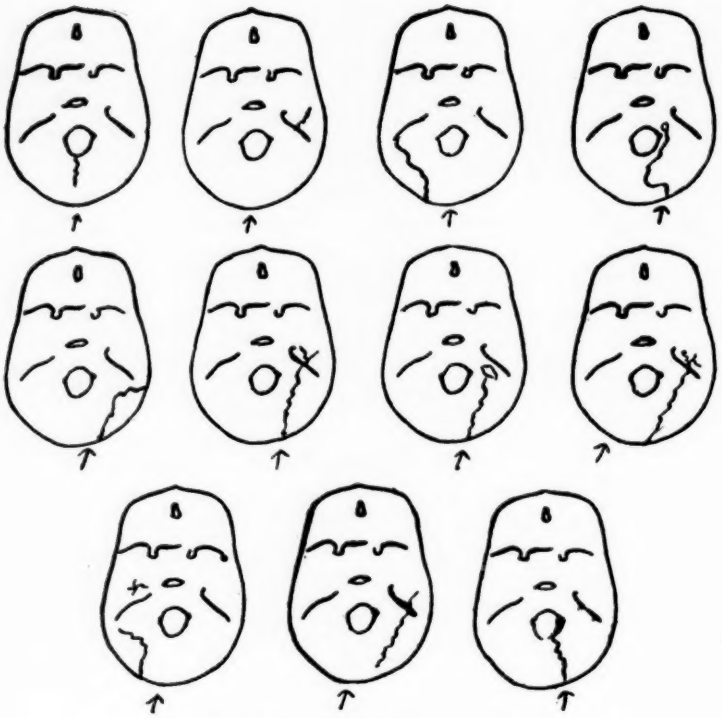

FIG. 11.—Lines of fracture resulting from occipital violence.

FIG. 12.—Lines of fracture resulting from violence of unknown direction.

The optic foramen was traversed in three out of the fourteen cases implicating the orbital fossa (21.4 per cent.), once on both sides. This does not quite justify the statement that the lesion is rare, but falls short of the frequency noted by Hoelder, who states that 50 per cent. of frontal fractures involve this foramen. Rawling's observation regarding the comparative immunity of the great vessels and the nerves of the base was borne out in a striking manner.

In one case all three fossæ were invaded on both sides, furnishing the second case of this lesion recorded as far as I am aware, the first being reported by Phelps (*New York Medical Journal,* January 14, 28, 1893).

The following are the diagrams grouped according to the estimated direction of the violence: (Figs. 6 to 12.)

The clinical records of hospital cases are less reliable than the pathological reports, unless we are sure that the observations regarding, for example, the pupils and the reflexes have been always made by those skilled in these branches; they offer much of interest, however, viewed with this reservation.

PUPILS.

The clinical records of these cases emphasized the fact that among the symptoms of basal fracture pupillary disturbance must be reckoned among the most constant and reliable, both for diagnosis and prognosis.

In the forty-four cases in which the condition of the pupils was noted, only thirteen were normal in size and reaction. The variety of the disturbance is illustrated by the fact that in seven cases both were small; in five, both large; in sixteen they were unequal (in three, one pupil contracted; in nine, one dilated; in one, both contracted, but unequally; in one, the left dilated and non-reacting, the right contracted and reacting; in two no note was made on this point); in three, the pupils were alike, but did not react to light. In a large number of these thirty-one cases it was noted that one or both pupils failed to react to light.

The importance of this point in prognosis is accentuated

by the observations of Lovett and Munro (*Medical and Surgical Records of Boston City Hospital,* 1889), who find that the pupils failed to react in thirty-nine out of fifty-three fatal cases of basal fracture in which they were recorded, whereas they failed to react in only one of twelve cases with recovery after the same diagnosis had been made and the pupils recorded. Similarly, Nichols (*idem.,* 1895) states that in fifty-four cases of head injury with non-reacting pupils, forty-seven died, and that in the twenty-four cases diagnosticated as basal fracture, *all were fatal,* from which he justly concludes that this is the most unfavorable single symptom.

Among the authorities laying special stress on the pupils, Phelps (*New York Medical Journal,* 1893) describes them as " variable, unsymmetrical, dilated, or contracted."

The disordered pupil is not susceptible of easy explanation; perhaps various factors take part. *The generally accepted paralysis of the third nerve causing dilatation of the pupil is untenable,* inasmuch as it is hardly credible that the ciliary fibres of this nerve should be so constantly affected without other sign of third nerve paralysis, to say nothing of the fact that the situation of this nerve in the wall of the cavernous sinus would naturally tend to protect it from injury.

The substitution of Rawling is hardly more acceptable. He attributes the disordered pupils to trauma affecting the cortical centre for contraction of the pupil, and states that the pupil is first contracted, then dilated.

One fact alone tends to eliminate cortical injury as playing a prominent part in the disordered pupils of basal fracture, namely, in most pupillary changes due to cortical influence, whether experimental or pathological, the alteration is bilateral and accompanied by other muscular phenomena as ptosis or conjugate deviation.

Doubtless various factors play a part in producing the altered pupils in this lesion, but *if disorder of any simple mechanism is to be credited with the production of the Hutchinson pupil or the other pupillary changes noted, the only lesion*

worthy of this place is disturbance, irritative or paralytic, of the intracranial fibres of the ciliospinal tract.

This tract after leaving the cervical sympathetic passes into the base with the carotid plexus, thence forward by the ophthalmic division of the fifth and its nasal branch, having first passed over the Gasserian ganglion. The fact is established that irritation of this tract causes dilatation, and its destruction contraction, of the pupil. The existence of dilator muscles in the iris seems to have been now fairly established (Langley and Anderson, Grenert, Devries, *et al.*). The fibres of the ciliospinal tract through which these muscles are presumably innervated would seem at least equally accessible with the third nerve to injury either from fracture of the base, or from uncomplicated middle meningeal hæmorrhage. In fact, I am inclined to think that at one point in their course they are peculiarly susceptible to injury, namely, at the apex of the petrous bone, in the region where the force transmitted along this buttress is suddenly interrupted and deadened by the buttress coming to an end. Nor is this tract open to the objection that other than pupillary symptoms should follow its disturbance, for the only other symptoms to be expected would be those of vasomotor disorder; such symptoms are by no means wanting, though they have lacked special study.

The proposition that initial contraction precedes dilatation can hardly be regarded as established. The following case which came under my observation within fifteen minutes of the accident would certainly point towards dilatation as a primary symptom.

CASE.—A teamster fell from his wagon, striking violently upon the back of the head. The accident occurred at six P.M., near the Massachusetts General Hospital, and he was brought immediately to the accident-room, where I saw him. There was extensive tear of the scalp in the occipital region. The patient was partially conscious, though unable to answer questions coherently; he was restless and combative, apparently alcoholic.

The left pupil was widely dilated and did not react to light. The right was normal. The epigastric, abdominal, patellar, and

plantar reflexes were wanting on both sides; there was no Babinski. The cremaster reflex was present and lively.

He was admitted to the House in Dr. Cabot's service, where I saw him again the next morning at nine o'clock. The pupils were then practically alike, and the left as well as the right reacted perfectly to light. All the reflexes had returned and had become active.

There was no bleeding from ears or nose, no subconjunctival hæmorrhage, no ecchymoses of lids or other region. The patient was kept under careful observation for three days, when he was allowed to go home. No further cerebral symptoms have appeared.

In casting about for an explanation of the dilatation and immobility of the pupil in this case, we must assume a unilateral and definitely localized, though temporary, injury. To me none seems more plausible than irritation by injury of the ciliospinal fibres on one side.

We may well leave this question still open when we realize the maze of uncertainty regarding even the course of the fibres, and the situation of the centres, constituting the primary reflex arc, as recently exhaustively reviewed by Thomas (*American Journal of the Medical Sciences,* December, 1903).

REFLEXES.

In the twenty-seven cases in which the condition of the knee-jerk was specified, it was stated to be normal in twelve, increased in seven, diminished in two, and wanting in six; in one case it was noted as still absent at the end of five days. In one case, definitely spastic, at the first examination the knee-jerks were exaggerated and the Babinski sign was present. The cremaster reflex was noted in two cases only, present in both. In three cases the general statement, " reflexes absent," appeared, without specifying the reflexes tested. This was an unfortunate omission, for the condition of the cremaster reflex would have been of interest in view of the exemption of this reflex from the general loss in the case of concussion and con-

tusion above cited. Further observations on this point are desirable.

Whatever lesson is to be drawn from the reflexes in these cases, it should not be regarded as specially diagnostic of basal fracture, but as resulting from violent jarring of the intracranial contents, accompanied perhaps by local bruising and by hæmorrhage, either limited or extensive.

The number of observations was small, but the proportion of cases in which the direction was towards lessening or loss was noteworthy. Doubtless some, at least, of the cases of exaggerated reflex represented a secondary condition; indeed, I suspect that in every instance the first result of a violent jar is a tendency towards lessening or loss of reflexes, even though sometimes speedily followed by their return and under certain circumstances by their intensification. The case of concussion and contusion above cited certainly shows that the reflexes (excepting the cremaster) may be wanting immediately after cerebral trauma, only to become extremely active within a few hours.

To attribute the lessened reflexes to shock of the spinal cord seems hardly satisfactory. In fact, if all the reflexes have their controlling mechanism in the cord, it is hard to see why the cremaster reflex should remain active while the rest are abolished. In case it proves that the cremaster usually escapes, it would seem to me far more probable that, while the mechanism controlling the cremaster reflex may have remained purely spinal, those controlling the other reflexes have passed cerebralwards in the higher development of the nervous system, as advocated by Grasset and others, though it seems probable that there is no single centre for the reflexes. Perhaps, as my colleague Dr. Paul has suggested, individuals are divided into those with predominating spinal reflex control, and those with predominating cerebral element, just as they are separated into visuels and auditifs on the sensory side of the language mechanism.

The exaggeration of reflexes is not so easy of explanation under Grasset's supposition; perhaps in some cases, as after

simple concussion, the reaction brings about an exalted irritability of the cerebral mechanism after recovery from the paralyzing effect of the trauma, or perhaps again, as I have suggested in connection with the exaggerated reflexes of chronic spastic paralysis, the lower spinal centres are ready to take up their latent function, and this even in an exaggerated manner when freed from cerebral control, especially under the stimulus of irritation, as by hæmorrhage, of the pyramidal fibres.

THE RELATION OF PROFUSE AND CONTINUED BLEEDING FROM THE EAR TO MIDDLE MENINGEAL HÆMORRHAGE.

The views of Rawling on this question are of sufficient practical bearing to justify careful analysis, and this I have made on the cases at hand with the following result. Bleeding from one or both ears was noted in twenty-one cases (in marked contrast to the ninety cases of Graf (*Deutsche Zeit. f. Chir.,* Band lxviii, p. 464) in which it appeared in seventy-seven instances). In most of the cases in which bleeding from the ear was noted, it seems to have been temporary and small in quantity. In three cases it was described as profuse, and in one case as persistent. *In none of these four cases was middle meningeal hæmorrhage found on autopsy;* nor, indeed, evidence of rupture of any of the large vessels, either arterial or venous; conversely, *middle meningeal hæmorrhage was found in nine cases, in eight without bleeding from the ear, in one with slight bleeding.*

RECAPITULATION.

1. In the majority of the cases the basal fracture resulted from impact received in the horizontal plane of the skull, whether upon the frontal or the occipital region or upon the side of the head.

2. While certain of the basal fractures extended from the vertex, there was no suggestion of the *contre-coup* of earlier writers.

3. The line of fracture tended to enter the fossa nearest the point of impact, and to extend in the general direction in which force was applied.

4. The lines of fracture in traversing the base tended to follow lines of least resistance, and in twenty-two of the fifty cases these lines corresponded more or less accurately to those indicated by Rawling, but the exceptions were too marked and too constant to allow the establishment of fixed rules.

5. The sella Turcica was implicated in 36 per cent. of the fractures. The petro-occipital and masto-occipital sutures furnished common lines of least resistance. Fractures extending across the base tended to run parallel to the petrous portion of the temporal bone and through the sella Turcica. Certain blows on the occiput tended to cause a line of fracture extending to the jugular foramen or across the petrous bone. The portion of the petrous bone containing the auditory apparatus showed itself peculiarly liable to fracture, more often transversely than longitudinally.

6. In seven cases (14 per cent.) the fracture was limited to the base after vault impact in the horizontal plane. Neither Rawling's theory of transmitted force nor the theory of bursting fracture of von Wahl and others suffices alone to explain these cases. The results of experiments with bodies of simpler structure would suggest that the bursting principle predominates in pure compression of the skull, and the principle of transmitted force in case of blows, while both play important parts in case of falls.

7. The orbital foramen was implicated in 21.4 per cent. of the cases of orbital fossa fracture.

8. Inequality and immobility of pupils, or both, furnish the most frequent and unfavorable sign of fracture of the base. In the forty-four cases in which the pupils were recorded, they were normal in only thirteen.

9. Injury to the ciliospinal tract in its intracranial course is a more probable cause of the Hutchinson pupil and the other pupillary changes than injury to the third nerve or to the cortex, though no single lesion explains all cases.

10. The reflexes may be lessened or lost in fracture of the base, as in any case of violent jarring of the brain. On the other hand, they may be increased even to spasticity, probably through direct pressure on the pyramidal tract as by hæmorrhage. It is probable that the initial result of the impact in all cases is a tendency towards lessening or loss of the reflexes.

11. Profuse and persistent bleeding from the ear does not suggest middle meningeal hæmorrhage. No middle meningeal hæmorrhage was found in the cases of profuse and persistent bleeding, and, conversely, hæmorrhage from this artery occurred eight times without, and once with only slight, bleeding from the ear.

LIGATION OF BOTH COMMON CAROTID ARTERIES.

REPORT OF A CASE IN WHICH THE RIGHT COMMON CAROTID ARTERY WAS LIGATED FOR INOPERABLE SARCOMA, WITH TEMPORARY IMPROVEMENT; LIGATION OF THE LEFT COMMON CAROTID SIXTY-NINE DAYS AFTER THE FIRST OPERATION.

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Assistant Surgeon to the Philadelphia Hospital.

THE report of the following case is from the service of Dr. A. C. Wood, in the Philadelphia Hospital.

J. S., colored; thirty-two years old; laborer; was admitted to the hospital June 1, 1903, with the history that two years ago, shortly after beginning to work in a chemical factory, his nose began to bleed at intervals, and he began to have pains in his head. These symptoms have continued to the present time with increasing severity. He has lost weight and strength. For the past six or eight months his right eye has gradually become more and more protruded.

On admission to the hospital he complained of weakness, pains in his head, difficulty in walking, and great difficulty in masticating and swallowing food. In appearance he was poorly nourished. The right eye extended beyond the bridge of the nose. On the right side, evidently involving the pterygomaxillary region, a mass was visible protruding from behind the lower jaw, and apparently attached to it. The jaw protruded somewhat near the angle, and considerable induration of the soft tissues existed below the jaw.

Examination of the nose and mouth on the affected side showed that the breathing was occurring almost entirely by the mouth. The right nasal cavity was completely obstructed by a mass of swollen tissue, which bled freely when touched by instruments. The turbinates on this side were not visible. The left nasal cavity was somewhat obstructed, but not entirely. That

the tumor was growing forward and inward was shown by the fact that the eye was protruding, and that the nose and mouth were involved by the growth on that side. Another small mass was evident in the parotid region of the opposite side, not involving the jaw.

The diagnosis of sarcoma was made. It is recorded in the notes that on June 10 the patient was prepared for operation, but that this was abandoned because of the difficulty in administering the ether.

After studying the case carefully, it was decided that the only justifiable operation was ligation of the common carotid artery, not with the idea of effecting a cure, which was manifestly impossible, but of affording at least temporary relief.

On July 22 Dr. Wood ligated the right common carotid under local anæsthesia by the Schleich method because of the previous difficulty in inducing general anæsthesia. The patient complained very little of pain during the operation. There were no cerebral symptoms at the moment the ligature was tied, or subsequently. The wound healed by first intention.

A slow but positive improvement followed the operation, as was shown best by the diminished frequency of the hæmorrhages from the nose, marked relief from pain in the head, and general comfort of the patient. The mass diminished perceptibly in size.

On September 24 it was noted that the hæmorrhages and the pains in the head were recurring. Ligation of the left external carotid was now considered and suggested to the patient, who readily agreed to it.

On September 29 the writer operated under cocaine with this object in view. The incision was made along the anterior margin of the sternomastoid muscle, from the angle of the jaw, about three inches downward. This was deepened until the digastric and stylohyoid muscles came into view. The internal jugular vein and common carotid artery were exposed, and followed upward from the upper border of the thyroid cartilage to well above the angle of the jaw. The artery gave off no branches in any direction, the search being made particularly in the submaxillary region. Finally, on working upward under the jaw, a group of vessels could be seen, apparently passing from the main artery towards the mouth and chin. These were believed to be the lingual or facial vessels or both. Because the patient

was under a local anæsthetic, and was showing symptoms of shock, although he had lost little blood, it was considered unwise to search further for the external carotid. It was now necessary to decide between closing the wound and placing a ligature on the common trunk. As the character of the tumor and its situation placed any other hope of relief out of the question, it was decided to tie that vessel. By the following morning the patient had passed into a condition of coma; the muscles of the back were rigid; the hands twitched, and the breathing was stertorous. He died later in the day.

The points of interest in this case are:

1. The presence of a malignant growth, which was so situated that radical removal was impossible, but which caused so much distress that some relief was urgently called for.

2. The impossibility of administering a general anæsthetic which had been demonstrated by previous attempts, and the successful and satisfactory ligation under local anæsthesia.

3. The temporary improvement which followed and was apparent to the patient and all those who saw him, in spite of the advanced stage of the disease at the time the operation was undertaken.

4. The high division of the common carotid which was demonstrated at the time of the second operation. This point was not observed on the right side, as the common trunk only was sought.

Such a high division of the common carotid is very rare. The writer, who performed the second operation, could not, from a comparatively long experience as a demonstrator of anatomy, recall such an anomaly in the cadaver.

In connection with the report the following facts are of interest:

According to the anatomical text-books of Morris, Gray, and Quain, an abnormally high division of the primitive carotid is more common than a low one. Normally, the bifurcation of the common trunk occurs opposite the upper border of the thyroid cartilage. W. J. Walsham ("Morris's Anatomy") says that the division may take place as high as the hyoid

bone, or even the styloid process (which is above the angle of jaw).

Authorities differ as to the dangers of ligating the only patulous carotid. Early writers, especially Galen, Valsalva, Morgagni, and Van Swieten, concluded, from experimentation on animals, that in these both carotids might be tied without serious results. This in the main was corroborated later by Bichat, Mayer Cooper, Mott, Jobert, and Porta. Sir Astley Cooper and Porta differed as to the comparative importance of the carotid and vertebral arteries. It was believed by Cooper that the carotids supplied the external parts of the head rather than the brain, and that only in the more advanced brains, as in man, did the carotids assume greater importance. Ligation of both carotids, according to Cooper, therefore, would not be followed by the same degree of cerebral disturbance as in man. Porta believed that the vertebrals were of no more importance to the brain than the carotids.

James Miller (*London and Edinburgh Monthly Journal,* 1842) held that, in view of the results of M. Jobert on animals, in the future the surgeon need not hesitate to secure both common carotids by ligature simultaneously, should circumstances imperatively demand it. Wardrop was also much inclined to this view. According to this authority, the blood supply is so abundant after ligature of the carotid that there is not the slightest danger to the parts within or without the cranium, from which the main stream has been diverted, " and no one now entertains the slightest fear for the intellectual and other functions of the brain."

Cheever (*London Medical Gazette,* 1855) believed this view to be both erroneous and dangerous.

Many instances are recorded in which one or both carotids were obliterated in man without destroying the life of the individual. Although in some instances delirium, convulsions, adynamia, phlebitis, thoracic and cerebral troubles have in many cases followed, yet in the aggregate the results have been more fortunate.

Pilz, of Breslau, in 1868, collected 600 cases in which the

common carotid had been tied. In twenty-seven both arteries were ligated. He found that the most common cause of death was cerebral disease. Of 386 cases of single ligature, ninety-six showed cerebral symptoms (about 25 per cent.); over one-half of the ninety-six died.

Of the twenty-seven double ligations, five were fatal. Two deaths occurred from cerebral disturbances, while in another case, in which convulsions took place, death did not result. Three others showed temporary disturbances of vision. In only one case were the two carotids tied simultaneously, the interval between the ligatures being only a few minutes; coma and death resulted. When the two sides were ligated, with some days or weeks intervening, the operation was not more frequently followed by cerebral disturbances than when only one was tied.

G. W. Norris, in 1847, from the records of the Pennsylvania Hospital, collected forty-two cases of ligation of the common carotid. Of these thirteen died. In his opinion, the operation of ligating this artery was too generally looked upon as one of comparatively little danger.

J. E. Erichsen, in his work on surgery ("The Science and Art of Surgery"), reached the following conclusions:

1. Ligature of one carotid artery is followed by cerebral disturbances in more than one-quarter of the cases, above one-half of which are fatal.

2. When the two carotids are ligated with an interval of some days or weeks, the operation is not more frequently followed by cerebral disturbances than when only one is tied.

3. Pathological investigation has shown that if the vessels be gradually and successively obliterated the patient may live, although one carotid and one of the vertebrals have been occluded by disease, and the other carotid ligatured, as in a case related by Rossi.

4. As in a case recorded by Davy, an individual may even live for a considerable time, though both carotids and both vertebrals be occluded, the cerebral circulation being maintained through the medium of the anastomoses of the inferior

and superior thyroids, and the deep cervical with the occipital artery.

5. The reason why more or less extensive obstruction of the arteries leading to the brain, by disease, may, as appears from pathological records, be unattended with cerebral disturbance, while this so frequently follows ligature (as has been pointed out by Pilz), is that in the former case the obstruction is gradual, so that the collateral circulation has time to be established, while in the latter, interruption is sudden.

PENETRATING WOUNDS OF THE CHEST, PERFORATING THE DIAPHRAGM, AND INVOLVING THE ABDOMINAL VISCERA.

CASE OF SUCCESSFUL SPLEEN SUTURE FOR TRAUMATIC HÆMORRHAGE.

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PENETRATING wounds of the thorax, perforating the diaphragm, and involving the abdominal viscera stand in a class by themselves, presenting features which require immediate decision in diagnosis and departures in treatment not generally advocated or practised. They are discussed in the text-books and literature from a diagnostic point of view, and the treatment most generally advocated is conservative, doubtless on account of the uncertainty of positive conclusions as to the organ or organs involved, and as well the greater uncertainty as to operative results.

Penetrating wounds of the chest, above and not involving the diaphragm, are of common occurrence, and are met with almost daily in the wards of the larger hospitals in cities. They form a very important part of the work of the active surgeon, and are eminently important and intricate, from their very necessary vital relations. In diagnosis many of them baffle interpretation. In treatment only the exceptional one bears active interference.

In comparison with the abdomen or brain, the thoracic region is an uncultivated field. Men who are bold in invading other parts of the body, hesitate, palliate, procrastinate, and often withdraw, when confronted with a penetrating wound of the chest, especially when it involves the abdominal viscera. The same hesitancy long controlled operators in dealing with penetrating wounds of the abdomen and organs in the upper

peritoneal space, and even at this time cases are seen of penetrating wounds of both lower chest and abdomen where a proper estimate cannot be made of the extent of the injury to the contained viscera, and they are treated conservatively with uncertain results.

Whether this reluctance is from the teachings of our text-books,—a large majority of which advises against operating in penetrating wounds of the chest,—or whether it is the rarity of cases, and consequent lack of experience in this particular region, is a matter to be determined. The fact is plainly apparent that these almost surely fatal wounds, many of them fairly easy to reach, are abandoned with a sterile dressing, a strapped chest, a dose of morphine, and no investigation as to the possibility of interference.

A penetrating wound of the chest below the sixth intercostal space, in the great majority of cases, should be investigated, not by probe or a finger, for neither can give one accurate information. The probe in such wounds should be discarded; the finger, by the possibility of infection and the admission of air and consequent pneumothorax, is far less accurate than the *resection* of a rib, where by actual observation a positive diagnosis can be made and direct treatment instituted.

In the cases here reported, it would never have been possible to determine the extent of the injury, had not resection of a rib been made.

In wounds below the sixth rib the important questions to be decided at once are: Has the diaphragm been perforated? Have the abdominal viscera been wounded? If it is decided that they have not, by what process of reasoning were the facts determined?

If it is decided that they have been wounded, what organ or organs are involved in the thoracic or abdominal cavities, and to what extent?

These are the intricate problems to be met with almost without hesitation, and on these conclusions depends one's future action.

In any penetrating wound of the thorax, anterior, posterior, or lateral, my experience has been—and that experience is borne out by the cases herein presented—that it is impossible to be accurate in estimating the extent of injury done to the viscera on account of the variable height of the dome of diaphragm, and the presence of the omnipresent omentum, which I found in every instance had temporarily plugged the wound openings in the diaphragm, and for the time masked the symptoms. In the cases referred to here there were penetrating wounds of the thorax through the diaphragm with serious involvement of the abdominal viscera.

American authors are strictly conservative in the management of wounds of the chest with or without abdominal complications. Senn, in his most recent work, written after his large experience in the Spanish-American War, says, "We have made but little progress in the treatment of penetrating wounds of the chest."

Direct operative treatment of visceral wounds of the heart and lungs is always attended by imminent risk to life from pulmonary collapse. This source of danger stands in the way of direct treatment of visceral wounds of the chest. Free incision of the chest wall has been strongly advocated by several French surgeons, in cases of penetrating gunshot wounds of the chest, with a view of arresting hæmorrhage by ligation, tamponage, or the use of cautery; but the profession as a whole, for good reasons, is opposed to such heroic treatment. Unless the source of hæmorrhage is one of the intercostals or internal mammary arteries, it is advisable to rely on Nature's resources, aided by such means as will favor thrombus formation in arresting the bleeding. As to treatment, he says further, "From what has been said, it is clear that the best treatment in penetrating wounds of the chest consists in hermetically sealing the wound of entrance and exit, if the latter exists, under strict aseptic precautions, immobilization of the chest by bandaging and rest, and in watching for and treating subsequent complications as they arise."

Thirty-three standard works on surgery—twelve English,

twenty-one American—express the same conservatism in the treatment of chest wounds, and as a matter of assumption include those of the diaphragm and abdominal viscera. Scant reference is made to this complication in any of them.

On the other hand, French and Italian surgeons advise and practise immediate interference in penetrating wounds of the chest, in wounds below the sixth intercostal space, and in heart and visceral wounds not immediately fatal, but not in gunshot wounds passing clear the body.

The recent and valuable work of Lejars on " Emergency Surgery" fixes clearly the practice in France in penetrating wounds of the chest involving or not involving adjacent viscera.

French and Italian surgeons investigate and operate in indicated cases, and their results show the wisdom of their practice.

There is one practical point, so very vital in the management of chest wounds with abdominal complications, upon which some stress should be laid. An American authority of note advises and recommends, in operating on chest wounds where the diaphragm has been perforated, that a thorough examination of the abdominal contents be made by enlarging the opening in the diaphragm. This, I think, is highly impracticable, and while it can be done it is not satisfactory.

This manœuvre I have tried in two of my cases, and in each instance it gave me limited information, and proved a detriment to the patient, on account of the necessity of enlarging the opening in the diaphragm. It is as indefinite and as unsatisfactory as it would be to determine a lesion of the abdominal viscera with a finger inserted through a small wound of the parietes.

My first operative case was done in 1891, for a stab wound through the sixth left costal cartilage, cutting the internal mammary arteries, pericardium, and heart. In this case, through a trap from the sternum, costal cartilages, and ribs, a radical operation was done, and the patient was alive five years afterwards.

In twenty-six cases of complicated wounds of the chest involving the diaphragm, the first ten, except one heart case, died from non-interference, of the remaining number two died within three hours of hæmorrhage, one from a perforating wound of the heart, one from embolism, and three from sequential infection. Of the remaining thirteen, one died one year after operation, and two after a lapse of eighteen and twenty months, respectively. The others are living. The remaining seven were operated upon after the manner to be detailed in this paper. From this experience, I am convinced that a large proportion of the cases of penetrating wounds of the chest should be followed out to the end of the wound, just as are abdominal penetrating wounds, and treated surgically.

In gunshot wounds of the chest where the ball has passed clear through the body, or into the body without causing an early fatal issue, the best practice is not to probe, but to clean the opening or openings and seal. This is the practice laid down by the most advanced workers in military surgery, and is a safe rule to follow. But there are exceptions to this practice, exceptions based on fundamental findings, often to be found if looked for, and one of which will be cited.

It is not my purpose to discuss military surgery or gunshot wounds of the chest, but as one of the cases to be referred to is a complicated case of gunshot wound of the chest, and one which I think would have surely died had he not been subjected to operation, I feel that it is a case directly in point, and one so exceptional that it will prove of more than ordinary interest in the study of penetrating wounds of this character.

These cases have been selected from my work with special reference to the illustration of the different types of chest wound complications.

The first is a gunshot wound, the ball striking the eighth rib, perforating the diaphragm, bisecting the left kidney from pole to pole, cutting the ureter and trunk of the renal artery, and lodging in the erector spinæ muscles.

Gus D., Irish, aged twenty-four years, was admitted to

Provident Hospital, July 29, 1902, 10 P.M. Shot in the left side whole stooping over.

Examination on Entrance.—Temperature, 97° F.; pulse, 88, small and compressible. Skin pale and cold, with profuse diaphoresis, marked dyspnœa, and apnœa. Complained of pain on inspiration over the left side of the chest. Blood oozing from wound in eighth intercostal space, two and one-half inches anterior to the left midaxillary line. Vomited frequently until anæsthetized. Heart, pericardium, and large vessels negative as far as could be learned. Dulness below third intercostal space. There were no indications of injury to the diaphragm or abdominal viscera, and from the fact that he had been shot through the eighth interspace would almost exclude abdominal complications. Balls do not turn corners unless they come into contact with some hard substance. The ball had passed through the eighth interspace, and it was fair to conclude that its course would vary but little from a straight line.

The omentum had plugged the wound in the diaphragm, and the abdominal and pleural spaces were temporarily normally separated.

Following the practice of examining the urine of all emergency patients while on the table, it was found that the bladder contained twelve ounces of bloody urine. This directed attention to the kidneys and abdomen. Examination of the abdomen showed muscular rigidity on the left side and absolute flatness from the twelfth rib into the flank, and the absence of abdominal respiration, a very important sign in men of a peritoneal lesion. The bladder was washed out, and a second catheterization made, and blood found again. As only one ball had entered the body, it was concluded that the abdominal viscera had been injured through the wound in the eighth interspace, and operation was indicated.

Operation.—Incision followed the angle of the eighth rib, five inches long; tissues raised and retracted, subperiosteal resection of about three inches of the seventh and eighth ribs. This gave ample space to reach any part of the diaphragm.

The wound in the diaphragm was treated by a purse-string suture of silk, after the manner suggested by Senn in perforating wounds of the stomach. Over this a continuous Lembert suture.

The pleural cavity was irrigated with salt solution. Wound closed, and the air aspirated with a Davidson syringe.

At this point the treatment of traumatic pneumothorax forces itself into prominence as a factor in estimating the result of the case in hand. In some cases the symptoms from this condition are grave, in others mild. The aspiration of the air from the cavity and a good firm strapping of the chest with plaster have eventuated in all of my cases in success.

Following out the investigation of the perforating wound in the diaphragm, an incision seven inches long was made to the left of the median abdominal line. The intestines and organs were examined with negative results, excepting a bullet wound in the upper inner surface of the kidney. This was closed with continuous suture of catgut, with the idea of protecting the peritoneum from infection incident to any procedure on the bleeding kidney.

An oblique incision was made in the left loin for the purpose of investigating the kidney. When the lumbar fascia was reached, it was found bulging into the wound, and the space dark with extravasated blood. On incising the lumbar fascia, there was an escape of dark clots, followed immediately by profuse arterial hæmorrhage. Temporary deep pressure by tampon controlled the hæmorrhage until the kidney was separated from its surrounding fat, and followed down to the ureter, which, with a large trunk of the renal artery, was found to have been cut by the ball. The kidney was removed. He made a slow but perfect recovery, and remains active and well more than a year after.

The second case is a stab wound of the chest through the eighth interspace and diaphragm and into the spleen. This case adds one more to the very few cases recorded of successful suture of the spleen for traumatic hæmorrhage.

Patient, Alfred C., aged twenty-seven years, was admitted to Provident Hospital, July 30, 1902. Discharged, well, August 30, 1902. Was asked to see and operate upon him by Dr. A. W. Williams.

Examination on Admission.—Temperature, 98° F.; pulse, 92, good quality. Complained of pain in and about the wound and in the left abdomen. Short, shrill, hacking cough. Unable

to lie down. Extreme dyspnœa, due to pulmonary collapse. Slight cyanosis. No hæmorrhage from wound on account of valve action of its margins. Heart normal. Dulness over the left abdomen. Slight muscular rigidity. No positive signs of hæmorrhage into the abdomen.

At this examination there were no indications for immediate operation. This is one of that class of cases usually treated on the expectant plan, and always results in death.

From this case, which proved the most interesting and instructive that I have ever met, many useful lessons have come.

After watching the patient for an hour, I concluded to operate on the progressively urgent indications. The pulse had increased from 92 to 140, with lessened tension. There was profuse diaphoresis, increased dulness in the left abdomen, with extreme muscular rigidity, and a leucocytosis of 30,000, his symptoms all pointing to active hæmorrhage.

Operation.—Incision following the angle of the eighth rib, retracted over the ninth; resection and method the same as in first case. The wound in the diaphragm was one inch in length, and firmly plugged with omentum; this was reduced by clamping with a pair of forceps, and carried into the abdomen. Wound in the diaphragm was closed, also the costal resection. The skin incision was extended downward over the left lateral abdominal wall into the cavity of the abdomen, which was found full of clots and free arterial blood.

Slight traction on the gastrosplenic omentum enabled me to deliver the spleen on to the abdominal wall for examination. It bled profusely from an incised wound extending from the phrenic to the lower part of the organ. To control the hæmorrhage, a turn of gauze with a drawn loop was put about the pedicle. Here I was confronted with a bleeding spleen. How should it be treated?

My first attempt at suture ended in complete failure by tearing out as I endeavored to draw the suture down. I therefore changed my method by selecting a full, curved, round Mayo needle threaded with No. 2 catgut. This I introduced one-half inch from the margin of the wound edges, and without the least force allowed the needle to follow its full curve, emerging from the opposite side of the wound the same distance as it entered, and making a triple loop without a reënforcing knot. Hot gauze

compresses were held on each loop as the edges were approximated, with the idea of causing the catgut to swell and engage opposing fibres, so as to make a firm line. Every suture put in in this manner held firmly.

After watching it for twenty minutes, I returned the spleen to the abdomen, and surrounded it with omentum, a very important part of the detail, on account of its well-known property of protection. The patient made a rapid and permanent recovery. He left the hospital in three weeks. (Fig. 1.)

This case was operated upon in July, 1902, From that time until October, 1903, I had been unable to find a case of successful spleen suture in literature. In November, 1903, Senn's article appeared, and gave the index number of Berger's article and a vast amount of valuable information on this subject. From this reference I have been able to see the original article of Berger's.

Suture of the spleen was first performed by Lamarchia in 1896; his patient died from secondary hæmorrhage. Madelung, in the year following, operated upon a similar case with recovery. Berger's article reports fourteen cases of splenorrhaphy, with two deaths, and ten cases treated by tampon with one death. Adding my case, we have fifteen cases with but two deaths. This destroys the theory that suture of the spleen for traumatic hæmorrhage is impracticable. Ten cases of tamponade with one death give a choice of two methods of treatment, from which 75 per cent. have recovered. For a method of treatment that had been rejected, abandoned, and discouraged, this is a most excellent showing, and will go a long way in impressing those who may have been sceptical that suture and tampon are the methods of choice for traumatic hæmorrhage of the spleen.

From my very limited experience, I firmly believe that it is the method of the application of the suture, and not the suture *per se,* that has caused the failures. To apply suture to a bleeding spleen as one would to almost any other tissue in the body will certainly eventuate in failure. It requires method, technique, and a proper adjustment of the omentum

in the completion of the operation to have a successful result.

As far as I have been able to learn from the Indexes of the Newberry Library, and the Library of the Surgeon-General's Office in Washington, this is the only successful case of suture of the spleen for traumatic hæmorrhage reported in this country, except the one reported by Tiffany, of Baltimore, in 1894.

The cases abroad are multiplying, and successes are becoming more frequent as technique and method improve.

In the management of traumatic hæmorrhage of the spleen, there are other methods of treatment which are strongly advocated, such as tamponade, cauterization, and forcipressure. Each of these several methods has its strong advocates, and perhaps may be of equal value in efficiency in the final result, but, as the cases are exceedingly rare, it will be a long time before any surgeon will be able to demonstrate the perfection of any special line of treatment, although it now looks as if suture and tampon were the methods of choice.

The third case is added to show the variance of penetrating wounds of the chest. This special type of penetrating wounds below the fifth interspace on either side should impress itself as a most formidable and usually fatal injury. They are wounds that it is positively impossible to diagnose without an exploratory incision until perhaps it is too late. And an exploratory incision here is just as necessary as it would be in a stab wound of the abdomen.

J. P., aged thirty years, referred to me by Dr. A. B. Schutz, stabbed July 30, 1903, through the sixth interspace, one inch anterior to the nipple line. Temperature, 97° F.; pulse, 110, fairly full and regular; respiration, 40; skin cold and clammy. Heart and lungs negative, except below the sixth rib, from which dulness extended downward to the tenth rib. Abdomen negative, arterial blood escaping from the intercostal vessels. As we could get no reliable history of the extent of the wound, exploratory operation was decided upon. Incision four inches long, following

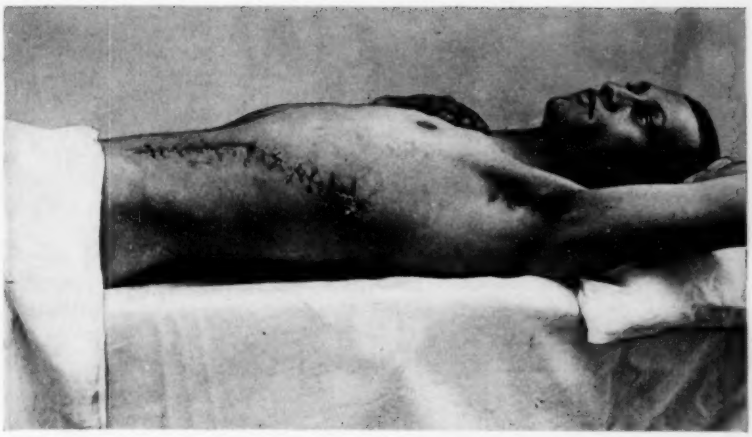

FIG. 1.—Spleen suture; showing line of incision from chest over abdomen to give ample operative field for thorax, diaphragm, and abdomen.

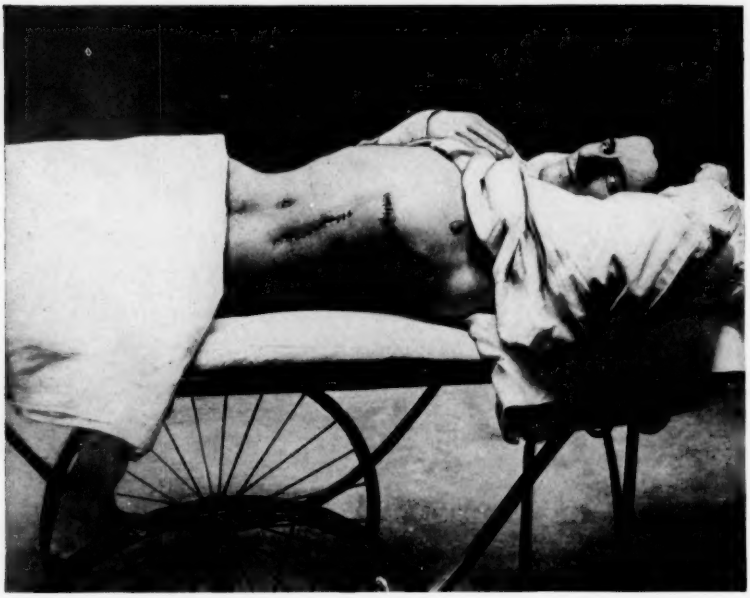

FIG. 2.—Stab wound through thorax, diaphragm, pericardium, and colon. Showing chest and abdominal incisions.

the curve of the sixth rib, retraction of tissues, and subperiosteal resection as described in case one.

On opening the pleural cavity, the patient was dangerously cyanosed on account of the pulmonary collapse, and inability of the right heart to accommodate itself to the emergency.

Two perforating wounds of the diaphragm, one on the outer or pleural side near the dome, and one in a direct line on the inner or pericardial side, were found. Also an irregular wound of the pericardium. No injury to the heart. The diaphragmatic wounds were treated with purse-string silk suture, over this a continuous Lembert. The opening in the pericardium was united with fine silk, the pleural cavity irrigated, and the costal opening closed. I continued the incision below the diaphragm, and carefully explored the abdomen, finding a punctured wound of the transverse colon. This is the only safe practice following penetrating wounds of the diaphragm.

The findings in this case, without symptoms special to any organ or viscera within stabbing distance of the walls of the thorax, again impresses one with the necessity of investigating selected cases of penetrating wounds of the thorax. Had not this case been early operated upon, it is fair to presume that the patient would have died. He recovered. (Fig. 2.)

OPERATIVE TREATMENT OF PERFORATING GASTRIC ULCER.

REPORT OF A THIRD CONSECUTIVE SUCCESSFUL CASE OF SUTURE.

BY A. B. ATHERTON, M.D.,

OF FREDERICTON, NEW BRUNSWICK, CANADA.

On September 19, 1894, I operated for the first time to close a perforation due to gastric ulcer. This was, I believe, the first successful case of the kind on this continent, and is so admitted in a paper read by Dr. Finney, of Baltimore, in 1900, before the Association of American Surgeons.

On March 29, 1899, I did a second operation, which also resulted successfully. Both these cases were reported in the *New York Medical Record*. The first patient was operated on fifteen hours after perforation; the second one in ten hours, and the one about to be reported in three and a half hours.

The first case occurred in a young anæmic female servant; the second in a man of over sixty years of age, who had suffered for many years from dyspeptic symptoms.

Report of Third Case.—On September 5, 1903, I was called by Dr. W. H. Irvine to see with him a man, thirty years old, who had dropped down on the street from a sudden agonizing pain in the abdomen. He had been troubled for some years with symptoms of indigestion, and two or three years ago gave up teaching school and took up manual work because it seemed to agree better with him. He had never vomited blood at any time. A few days ago he began to have attacks of quite severe pain with flatulence, coming on about three hours after meals. He, however, made little or no change in his food, and at noon to-day ate a hearty meal. At 5 P.M. he treated himself to some pears, and immediately afterwards was seized with the excruciating pain in epigastric region above mentioned. Dr. Irvine was at once sum-

moned, and gave him three-quarters of a grain of morphine in two doses. In spite of this the pain continued very severe, and about 6.30 P.M. I was sent for by the Doctor, who began to suspect a perforated gastric ulcer.

I found a fairly healthy looking man evidently suffering a good deal and doubled over forward from the abdominal pain. The belly-wall felt extremely hard and rigid, especially at its upper part. It was also tender on pressure here. No manifest distention present, and no loss of liver dulness.

I agreed with Dr. Irvine's diagnosis, and we had the patient at once removed to the hospital and prepared for operation.

The operation was begun at 8.30 P.M., Dr. McGrath giving the anæsthestic, and Dr. Irvine assisting me. An incision made from the ensiform cartilage to near the navel. A few bubbles of gas escaped on opening the peritoneum. Stomach somewhat distended, and its pyloric end was covered in places with lymph. There was now also seen an opening of about the size of a crow's quill on the anterior wall just at the narrowest part of the pylorus, from which flowed mucus and a chocolate-colored semi-solid matter. I closed the perforation by two rows of silk sutures, the inner one including all the coats and the outer being a Lembert. The adjoining parts were then cleansed with gauze pads, and the abdominal wound united with through-and-through silk-worm-gut sutures. The usual antiseptic dressings, with adhesive straps and bandage.

September 6, 9 A.M. Slept six hours. No vomiting since operation. Pulse, 76; temperature, 100° F. Just before operation, the pulse was 100 and temperature 99° F. At 9 P.M. his pulse was 70 and temperature 98.8° F. During the day was troubled with gas, and a turpentine enema was given, which resulted in a fair stool and got away a good deal of the gas.

September 7. Slept well; pulse, 70; temperature, 98° F.

September 8. Doing well. Pulse and temperature normal. Wound dressed. It looks all right.

September 16. Has gone on perfectly well. Sutures all out to-day. Has an egg and some toast and junket every day now.

September 23. Doing well. Ate a banana five days ago without anybody's consent; was none the worse for it, apparently.

September 26. Left hospital, being the twenty-first day after operation.

Remarks.—The main element in securing a favorable result in operations for perforated gastric ulcer is unquestionably an early diagnosis and a prompt resort to surgical treatment. The chief reliance, we think, should be placed on the location and severity of the pain, together with the board-like hardness of the abdominal muscles, in determining the diagnosis. Considerable help is afforded in most cases by the previous history of dyspeptic symptoms. Not much dependence can be placed on the absence or otherwise of liver dulness. Only once in some half-dozen of these cases have I noticed so much tympanites as to obscure the normal percussion sound over that organ. Neither can we derive much help from observing the presence or absence of shock. Usually, more or less will be met with at the outset, but this is not always the case. Some vomiting commonly occurs, and at times a little blood is found in the vomited matter.

A NEW OPERATION FOR INTESTINAL STENOSES.

BY THEODORE A. McGRAW, M.D.,

OF DETROIT, MICHIGAN,

Professor of Surgery in the Detroit College of Medicine.

It has been the experience of all surgeons that resections of the colon are followed by a high rate of mortality. Wölfler, in a paper read before the German Surgical Society in 1896, stated that 54 per cent. of such operations on the large and small intestines resulted in death. Körte, in nineteen cases of colonic resection for cancer, had seven deaths; but as six of the nineteen cases were in the ileocæcal region, and as all of the six recovered, there remained thirteen cases involving other portions of the colon with a mortality of nearly 54 per cent. The fatality rate differs, therefore, with the location of the disease. The greatest success has been attained in the ileocæcal region, and next to that with the sigmoid, while radical procedures on the transverse colon and the colonic flexures have been exceedingly disastrous.

The success attained in the ileocæcal region has probably been due, in large part, to the ability to isolate that part of the gut and to protect the abdominal cavity from infection. It may be, too, that the intestinal contents, which in case of obstruction in that region accumulate in the ileum, are less virulent than those which collect in the colon when the obstruction is farther down. However that may be, a careful study of these operations leaves little doubt that the greatest danger is the exposure of the abdominal cavity to infection from the cut bowel. Besides this, the causes of the high rate of mortality are to be found in the general condition of many of these patients when they are operated upon, the diseased condition of the gut above the seat of obstruction, the changes which take place in the intestinal contents from long retention and

from their mixture with secretions from the congested mucous membrane, and from the attempt to make end-to-end anastomoses in bowels differing enormously in size. Many of these operations, too, have to be made at a time when the partial chronic obstruction has become complete, when the patient has become exhausted by a long, painful struggle, and when the bowels have become acutely congested and inflamed.

The operation becomes then urgent, and the surgeon may hardly allow himself time for a thorough examination of the case, and cannot delay action until he has brought the patient into a better condition. Under such circumstances operations are done at a great disadvantage, and many patients die who might have been saved if operated on at an earlier period. If the bowel is resected, when the abdomen is open the greatest difficulty is experienced in preventing infection. The whole intestine, except that part below the seat of stenosis, is full of long retained fæces, which have acquired a highly virulent quality. To empty the gut requires a long time, during which the intestines are more or less exposed. If an end-to-end junction of the cut bowel is attempted, the surgeon is puzzled by the difference in caliber and in quality of the two ends, for the proximal end is dilated often to a diameter of three or five inches and has walls which are knobby and parchment-like, while the distal end is contracted to half of the normal size and is soft and pliable.

The German surgeons have sought in various ways to overcome these difficulties. Mikulicz was the first to abandon the "one time" operation and to resort to a method of operating in which the gut in one operation was fastened outside of the abdominal cavity, in a second resected, and in a third repaired. His method is as follows:

First of all, the abdomen is opened and the diseased area freed from its attachments and stripped of its blood-vessels.

The mesenteric glands are removed and the rents in the mesentery repaired.

The two limbs of the affected coil are then brought parallel to each other and fastened together with Lembert stitches. The

tumor and three or four inches of the intestine are next brought out of the wound and the abdomen closed snugly around them. The parts to be removed having been deprived of their blood-vessels mortify, and in two or three days are ready for removal and are cut off. A glass tube inserted into the afferent branch carries off the fæcal discharge. Two weeks later, the spur between the two bowels is divided by a clamp, the adhesions formed between the two rendering the operation without danger to the other viscera. Of twelve cases thus treated, ten recovered.

Hochenegg has had success with a similar operation, without, however, resorting to that unnecessary measure of depriving the gut of its blood-vessels, and thus inducing gangrene. He brings the tumor well out of the abdomen, prevents its retraction by passing a fold of iodoform gauze through the mesentery, and closes the abdominal wound around the bowel with sutures. After a few hours he makes a small opening in the distended afferent limb, inserts a glass tube, and empties the intestine. At the end of ten or twelve days the abdomen is reopened, the tumor and adjacent parts of the gut are excised, and the two ends united with circular suture.

The objections to both of these procedures are the multiple operations necessary to their completion.

The deliberate production of gangrene in Mikulicz's procedure seems to me unnecessary and useless, while the cure of a false anus by clamping the spur is tedious and imperfect when it does occur, and often fails to take place even when the spur has been destroyed. In that case the surgeon has to resort again to a laparotomy and to resection of the bowel. Hochenegg's procedure necessitates an opening of the abdomen and a junction of the bowel in an exhausted patient, who has barely recovered from a laparotomy.

That these secondary operations are by no means devoid of danger is proven conclusively by Wölfler's statistics, in which a mortality of 22 per cent. is reported in operations for the cure of false anus.

Stimulated last winter by a fatal case of colonic resection

for cancer, I have given a good deal of study to the technique of these operations. It has seemed to me that the existing methods of procedure might be very much improved, and I venture to bring before the profession a method of operation which, I hope, may prove in practice what it seems to me to promise in theory.

The main and essential things in operations for colonic cancer are:

First. The protection of the abdominal cavity from infection by deferring the evacuation of the intestinal contents until the abdominal wound has been completely closed and hermetically sealed. This can be done only by bringing the tumor out of the abdomen and fastening it there while the gut is opened.

Second. The avoidance of all serious secondary operations which would bring new risk to the patient. I propose to accomplish these objects in the following manner:

Given a tumor or a stenosis of the colon, every effort should be made to locate exactly the seat of disease, as the knowledge of its location enables the surgeon to make the abdominal incision at the most favorable point. For this reason, such cases should be carefully studied beforehand, and never operated on without the most careful investigation. If the tumor can be felt, its location is plain. In the many cases in which it cannot be felt, we may, nevertheless, locate, approximately, the seat of the stenosis by studying the reactions of the afferent and efferent limbs of the bowel.

That contraction of the intestine which is the invariable accompaniment of an obstruction can often in a thin person be seen through the abdominal wall. There is a wave of distention which begins at a distance from and ends at the point of stricture. Careful examination of this wave-like tumor will often show the acute observer in what portion of the abdomen the stenosis is situated. If the stricture does not completely close the gut, the passage of fluids or semifluids and gas through the narrowed portion is announced by a gurgle, which is most distinct over the seat of trouble.

The location, then, of the end of the abdominal wave and

of the loudest gurgle will in many patients enable us to locate the seat of disease.

We may also locate it by watching the effect of a large high enema in the efferent bowel, for, if an enema of water were pumped into the colon in sufficient quantity to dilate it, we should find that the distention would occupy only that portion of the bowel below the stricture. Distention with gas would answer the same purpose. In very fat persons, the phenomena thus caused are not so perceptible, and in some cases complications of any kind might obscure the diagnosis. Indeed, careful and repeated examinations can alone give that surety in such cases which would warrant the surgeon in directing his operation by his diagnosis.

If the tumor can be even approximately located, the abdomen should be opened directly over it. If that is impossible, the exploratory incision should be made in the median line. The tumor or stricture having been found, the coil in which it is seated should be drawn out of the abdomen, and, if necessary for this purpose, adhesions should be broken or cut, enlarged mesenteric glands should be then removed, and the mesentery repaired. At this stage, the two limbs of the intestine leading to and from the tumor, at a sufficient distance from the seat of disease, should be joined together by Lembert sutures and an anastomosis made with an elastic ligature. If the exploratory opening in the abdomen should seem best adapted for the purpose, the wound should now be closed snugly around the protruding coil, the ligatured portion remaining in the abdominal cavity, and the tumor, with a length of gut of two or three inches, outside of the abdomen. If the exploratory incision is made in the median line and the tumor is found to exist at either angle of the colon, it would be better to close the median incision and make a new one over the tumor, just large enough to permit of its easy exit. In every case the tumor should be drawn out of the abdomen at that point which would most nearly permit the resected intestine to occupy its normal position. (Fig. 1.)

When the wound has been closed and sutured to the pro-

truding intestine, a firm silk ligature should be tied around the efferent limb just below the tumor and the gut cut off below it, care being taken that not the least portion of its contents is allowed to come in contact with the wound. This part of the

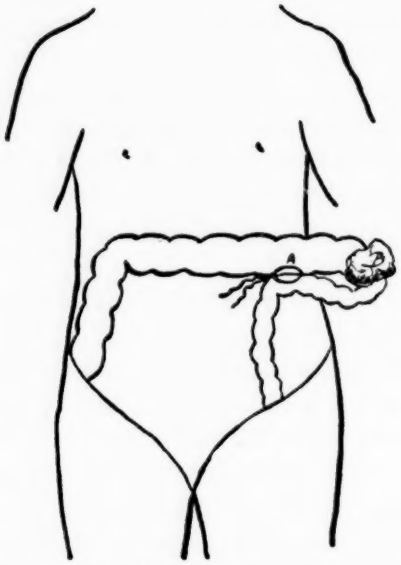

FIG. 1.—Cancer of colon at splenic flexure. *A*. Anastomosis made by elastic ligature between the afferent and efferent limbs of the colon. *B*. The cancer, which has been drawn out of the abdomen through a lateral incision.

gut is small, contains little fæces, and is easily cleansed and disinfected. It may now be closed with a circular suture, inverted into itself, and pushed in until its outer surface no longer projects beyond the level of the skin. (Fig. 2.) A few Lembert sutures will now hold it in position and the integument may be brought over it and sutured. In this way the efferent limb is, once and for all, disposed of.

When the gut is divided just below the ligature, the afferent distended portion should be seized by an attendant and wrapped in gauze. As soon as the efferent limb has been hidden under the integument, the surgeon should examine carefully the sutured line which fastens the proximal bowel to the integument, and see that the abdomen is thoroughly closed.

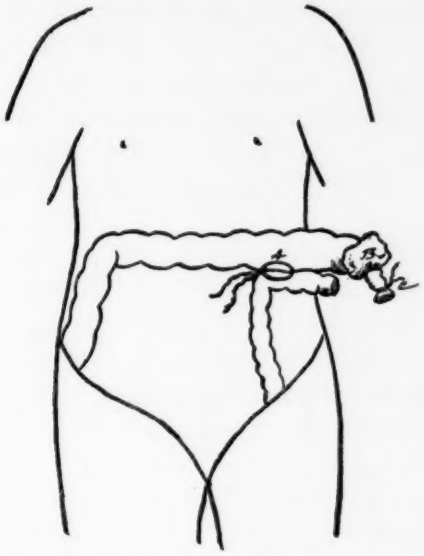

FIG. 2.—A ligature has been tied around the efferent limb at *c*, and the bowel divided below it

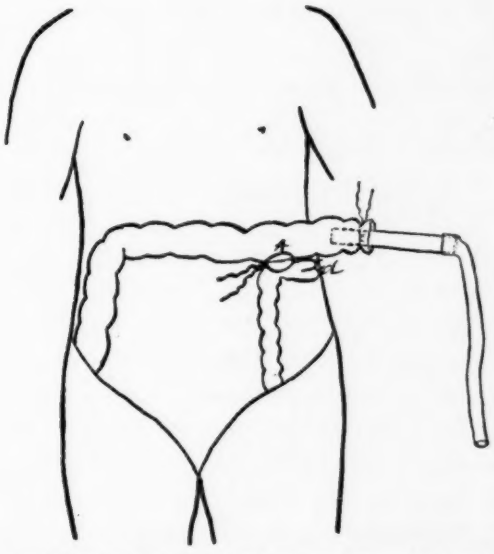

FIG. 3.—The divided end of the efferent limb has been inverted at *d* and the skin sutured over it. The cancer has been removed, and a glass tube inserted into the proximal end of the colon for the evacuation of fæces.

Layers of gauze soaked in collodium should then be placed over the whole wound so as to seal it hermetically. A large trocar, such as has been used for the discharge of fluids from ovarian cysts, in operations for the removal of those tumors, may now be thrust into the intestine and the fæces discharged. A rubber tube attached to the trocar will carry them into a proper receptacle.

When the gut has been thoroughly emptied of fæces, the diseased portion should be cut off and a large glass tube inserted into the bowel and tied in place by an encircling ligature. To this a rubber tube is attached for the disposal of fæces. (Fig. 3.) At the end of four or five days, the fæces will find their way through the new channel of anastomosis and pass into the lower bowel. As soon as this is determined by fæcal discharges per rectum, the tube may be removed, the gut sutured and turned into itself, and the wound in the integument closed over it. (Fig. 4.) In this way we shall have guarded the abdomen from all contamination from the opened bowel, have excised the diseased portion, and made the anastomosis and completed the work in what is practically but one operation, for the final disposal of the proximal end by inversion and suture can hardly be dignified by the name of operation.

It is evident that the success of this procedure will depend upon the success of the entero-enterostomy with the elastic ligature.

It must be remembered that the great distention of the proximal portion of the colon will tend to force a discharge through the smallest aperture. For this reason the rubber ligature must be passed with the greatest care. I should not trust an ordinary needle for this purpose, because, even though the ligature is put on the stretch, it would offer a shoulder which might unnecessarily enlarge the opening made by the needle.

The McLean needle, which I have used in anastomoses of the bowels, does away with the shoulder made by the doubled rubber thread and permits the use of a ligature much larger than itself. Notwithstanding the slight shoulder caused by its

ferrule, it is an excellent instrument. The Smith needle is absolutely free from all shoulder and answers the purpose admirably. If the large-sized rubber is used with this needle, it can be passed while on the stretch, and will immediately expand beyond the size of the aperture, filling it completely.

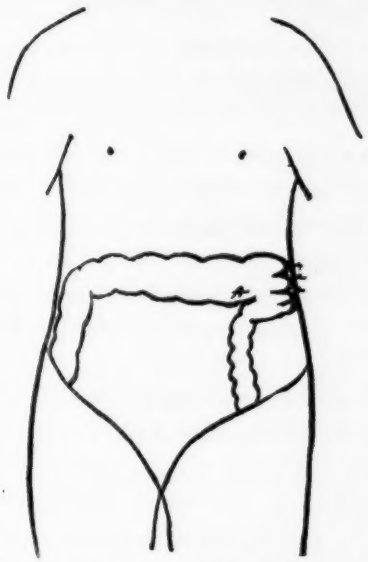

FIG. 4.—The anastomosis at *A* has been completed, and the end of the proximal limb has been inverted. The skin has been sutured over the intestine.

The thickest portions of the large intestine are those occupied by the longitudinal bands, and these should be chosen for the passage of the needle, as the danger of any extravasation would be diminished thereby to the uttermost. This operation may be used on all forms of intestinal stenosis.

PNEUMOCOCCUS PERITONITIS.

A REPORT OF FIVE CASES.

BY FRANK S. MATHEWS, M.D.,

OF NEW YORK,

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DURING the early part of the year 1901 there came under the writer's observation three cases of pneumococcus peritonitis. These formed the basis of a short paper read before the Roosevelt Hospital Alumni. This paper was not printed. Since then two other cases have been seen, all five occurring in the medical or surgical wards of St. Mary's Free Hospital for Children.

During the past year two excellent articles have appeared in German publications dealing with the subject of pneumococcus peritonitis. The one by Jensen (*Archiv für klinische Chirurgie,* 1903, lxx, p. 91), of Copenhagen, gives the histories of 106 cases, and to the article are appended 134 references to literature. The article by von Brüns (*Beiträge zur klinische Chirurgie,* 1903, xxix, p. 57), of Tübingen, was briefly reviewed in the December, 1903, number of this Journal.

In general, these articles are in accord, and many of their statements are borne out by findings in the five cases to be reported. Points to be especially noted in our cases will be presented after the histories of the cases.

In symptoms, course, pathological anatomy, and prognosis, pneumococcus peritonitis differs considerably from other types of peritonitis. A knowledge of these characteristic features of the disease will considerably aid one in making a diagnosis. The following description of the disease is largely borrowed from the articles of Jensen and von Brüns.

Frequency.—It is rare as compared to other pneumococcus infections. Netter, in 104 pneumococcus infections of adults,

found no case of peritonitis, and in forty-seven such infections in children found it once. Moreover, among 140 cases of peritonitis bacteriologically examined he found the pneumococcus but twice. This is the more remarkable when it is added by Netter that in autopsies on pneumococcus pneumonias he was regularly able to demonstrate the pneumococcus in cover-slip preparations from the peritoneum. Flexner and others have confirmed this observation. Jensen records 106 cases of pneumococcus peritonitis. Several observers have seen from five to eight cases each. This would suggest to us that the disease is more frequent than hitherto supposed or than would be indicated by the total of 106 cases.

Age.—It is perhaps three times as frequent in children as in adults.

Sex.—Under fifteen years of age it is seven times as frequent in girls as boys. The two sexes are equally affected in adult life.

Mixed infection is infrequent, but has occurred when the disease has been the result of intestinal processes, as appendicitis and gastric ulcer.

Pathological Anatomy.—To one familiar with pneumococcus empyema very little need be said. There is a very fibrinous exudate without odor, of greenish yellow color. The consistency varies as in empyema; in one case the exudate is practically solid, in another quite fluid, with perhaps large masses of fibrin. One to four litres of pus have been evacuated in reported cases.

Localization.—There is a decided tendency for the process to become localized in the pelvis and hypogastrium, forming there a large, thick-walled abscess. There are other cases in which the process is diffuse, covering every spot of peritoneum with thick fibrinous exudate.

Termination.—A considerable number of cases have been discovered at autopsy; a number have ruptured through the abdominal wall at the umbilicus, one has discharged through the vagina. A large percentage of the incisions for hypogastric abscess have resulted in cures.

Associated Lesions.—Among these the most frequently observed are empyema, pneumonia, pericarditis, otitis media, and intestinal lesions. Salpingitis has been noted a few times in adults. In the majority of cases reported the peritonitis has appeared primary. There has been no history of pneumonia, nor has pneumonia, as a rule, been present at autopsy. In a few cases a pneumonia has followed the peritonitis.

Symptoms.—The most characteristic clinical picture is seen in the apparently primary cases, and three stages may readily be distinguished:

1. Sudden onset with high fever, vomiting for a day or two, tenderness and distention. There is little muscular rigidity, and the pain and distention are not so marked as in the other types of peritonitis.

2. After a few days vomiting ceases, temperature falls often to normal. Diarrhœa, often present in the first stage of the disease, is the rule in the second stage. The amelioration of symptoms is pronounced, appetite returns, and the child looks better.

3. Then with the increase of exudate there appears a tense cystic mass in the hypogastrium, temperature rises, and shows marked morning and evening remissions and exacerbations. There is cachexia and weakness, and the case terminates in from one to four months in death from exhaustion or in recovery following operation or perforation at the umbilicus.

Prognosis.—This is one of the less virulent types of peritonitis, since there is such a pronounced tendency to the localization of the process by the abundant fibrinous exudate thus forming one or more abscesses. As already mentioned, there are two types of the disease,—the diffuse, which may be expected to result fatally unless future experience shows that cases can be headed off by early operation, and the localized, which usually results fatally, unless operation is undertaken.

But when the localized form is operated upon, 80 per cent. of cases may be expected to recover. This high percentage of recovery has been obtained in cases operated upon

from seventeen days to four months from the beginning of illness and in presence of one to four litres of pus.

Differential Diagnosis.—The late stages of the disease simulate tubercular peritonitis. In the second stage with diarrhœa and slight distention the picture is not unlike that of typhoid. In the early stage one may question whether a peritonitis exists at all, since distention and pain are not necessarily marked, and the bowels move readily with cathartics. The question of peritonitis secondary to appendicitis will arise, and in some cases the appendix has been the source of infection. The acute stage passing into one of falling temperature with localization of symptoms in the pelvis may simulate gonorrhœal peritonitis.

Etiology.—Following Jensen, we may recognize the following methods of infection:

1. Through a wound. One such case is reported following a hernia operation.

2. Through the diaphragm. This may be either an actual extension of inflammation from the thorax through the tissues of the diaphragm or a transportation of bacteria by the lymphatics from the thorax to the abdomen. This can undoubtedly occur, even though it involves a retrograde transportation, that is, a turning about of the usual lymph current, which is from peritoneum to thorax.

3. Through the genitals. The greater frequency of the affection in girls naturally has suggested the genitals as a portal of entry. However, there is no other proof of it than this single fact. Further, pneumococcus tubal infections are very rare, and have only been observed in adults. Moreover, in adult life males are as often affected as females. We must admit that there is at present no satisfactory explanation of the much greater frequency of the disease in girls.

4. Through the intestinal tract. Flexner was the first to report a pneumococcus peritonitis secondary to intestinal ulceration. It has also followed ulcer of the stomach.

5. Through the blood. Pneumococci are often found in the blood in pneumonia, and from this source bone and joint

infection may occur. In the same way in a pneumococcus septicæmia peritonitis may appear as a terminal inflammation.

6. From pneumococcic foci in the abdominal organs.

The depositing of the cocci in the peritoneum is not alone enough, however, to cause the peritonitis, as is shown by the frequent presence of the germs in cases of pneumonia in the peritoneum without a peritonitis. Some predisposing factor must be assumed.

CASE I.—*Empyema, Meningitis (?), Peritonitis, no Pneumonia.*

E. B., aged three years, female. Patient has been sick several days. Symptoms same as those on admission, *i.e.*, fever, extreme restlessness, abdominal pain, and constipation. There was moderate distention of abdomen and right thigh was slightly flexed. The mental condition was striking; the child would lie still for a few moments with eyes closed, but the slightest touch upon the skin, as, for instance, to feel pulse, would cause her to cry out and pull away her hand. The abdomen, though distended, was not more sensitive to touch than other parts of the body, and the distention was largely relieved by enema. The forepart of the chest, which alone was examined, revealed nothing. The diagnosis seemed to lie between peritonitis of unknown origin and meningitis. After admission, the bowels moved well as the result of an enema. Though there were no focal symptoms of meningitis, the peculiar cry and hyperæsthesia were suggestive of it. She was kept under observation twenty-four hours, and then, though diagnosis was no clearer, it was thought better to explore the abdomen. Accordingly, under ether, the writer made a one and one-half inch abdominal incision. Coils of intestine were distended and of a bluish color, but there was neither pus, fibrin, nor fluid of any kind in the abdomen. The wound was closed. Patient rapidly recovered from ether, and shortly afterwards began to emit short, sharp cries at intervals. Temperature ranged from 101.5° to 103.5° F. For two days following operation there was drowsiness, at times restlessness. She took fluids well and never vomited. She died two and a half days after exploration.

Autopsy revealed small empyema behind lower part of left

lung; there was not more than an ounce of pus. Hypostatic congestion, but no consolidation of lungs. There was a peritonitis of the hypogastric region and pelvis; stomach and liver not involved. There was little fluid anywhere, but intestines were glued together by a yellow fibrinopurulent material. The wound showed no gross evidence of infection.

Diplococci with capsules were stained in pleural and peritoneal pus. Cultures were made on Loeffler's serum, and gave an abundant growth of diplococci apparently in pure culture.

CASE II.—*Empyema, Peritonitis, no Pneumonia.*

W. S., aged two and one-half years, male. Admitted to hospital October 5, 1901. The illness, which has extended over eight weeks, has been characterized by chills, fever, and cough. Pneumonia of right lung diagnosed before admission. Temperature on October 6, 101° F.

October 7 transferred to Dr. Charles N. Dowd's service. Portion of eighth rib on right side resected by Dr. Munger, the House Surgeon. Sixteen ounces of pus evacuated. Temperature normal for next three succeeding days; from the fourth to seventh day after operation it ranged from 99° to 104° F. Abdominal distention gradually appeared, and there was vomiting during the last twenty-four hours of life. Patient died seven days after operation.

Autopsy showed no pneumonia. Right lung adherent to chest wall in front and behind. Empyema cavity extends from apex of lung to diaphragm. There was no retention of pus. Diaphragm intact. The abdominal cavity contained thick yellow pus not uniformly distributed, but found chiefly along ascending colon, under surface of liver and in pelvis. Microscopical examination of thoracic and peritoneal pus by Welch's method of staining revealed the pneumococcus.

Dr. Dowd states that in this case during life the child showed great prostration and the large abdomen of rickets, yet there was no tense abdominal distention, severe pain, or flexion of the thighs.

CASE III.—*Empyema, Suppurative Pericarditis, Peritonitis, Pneumonia.*

J. R., aged three years, male. Admitted to hospital service of Dr. Swift May 2, and died May 5, 1901. Illness of two weeks' duration. Temperature on admission, 102° F. There was pallor,

abdominal distention and flatness over posterior part of right chest. Bronchial voice and breathing over both lungs.

Temperature ranged from 102° to 105° F., and patient died in convulsions.

Autopsy showed two ounces of pus in right chest, lower part of left lung adherent and consolidated.

Three ounces of thick yellow pus in the pericardium.

There was a general peritonitis with moderate amount of fluid. The process was most marked on the upper surface of the liver. Coils of gut adherent. Pelvis contained straw-colored fluid. Pneumococci found in pleural and peritoneal pus, not sought in pericardial pus.

Dr. Dowd recorded that before death the child gave no evidence of peritonitis except pain. He frequently put his hand to the abdomen. Bowels moved regularly, abdomen was soft, and not so tender that touch elicited marked pain.

CASE IV.—*Empyema, Diffuse Peritonitis, no Pneumonia.*

M. D., aged five years, female. Admitted to hospital, June 3, 1903, with physical signs of empyema of right chest.

June 4. Operation by House Surgeon, Dr. Lewis. Portion of rib removed and a pint of pus evacuated.

June 6. Vomiting.

June 7. Rise of temperature, abdomen distended and tender. Enema effectual.

June 9. Temperature normal.

June 14. Abdomen is less tense, but there is still tenderness on palpation. The bowels are loose.

June 15. Died.

Autopsy.—Abdomen not distended. All abdominal viscera covered with and agglutinated by a thick, greenish yellow, nearly solid exudate. The only portion of peritoneum not thus covered was the upper surface of the left lobe of the liver. The lining of the empyema cavity gangrenous. Cavity perfectly drained. Lungs show slight hypostatic congestion. The muscular tissue of the diaphragm appears not involved, although peritoneum below and pleura above it are.

CASE V.—*Pneumonia, Peritonitis.*

J. K., aged three years, male. Admitted April 25, 1904, to the service of Dr. Swift. The child has been sick for two weeks

with cough, fever, pain in the abdomen, and nose-bleed. Child is anæmic. Examination of chest and abdomen negative.

May 1. Marked dyspnœa and restlessness. Dulness over middle and lower lobe of right lung. Pain in the abdomen, vomiting, and constipation. Bowels moved with enema. Abdomen tender.

May 2. Urine contained abundance of albumen, granular and hyaline casts.

May 3. Leucocyte count, 40,000.

May 5. Died.

Autopsy.—Left lung shows slight hypostatic pneumonia. Nearly the whole of the right lung is covered with yellowish fibrin. There is a gray hepatization of the greater part of the middle lobe and a red hepatization of part of the lower lobe. Right heart enormously distended.

Peritoneum through most of the abdomen shows no change. The true pelvis is filled with rather thin fibrinous exudate. Fibrinous exudate also surrounds the caput coli and lower part of descending colon. No peritonitis around stomach, liver, or diaphragm. Colon empty and contracted, small intestine moderately distended.

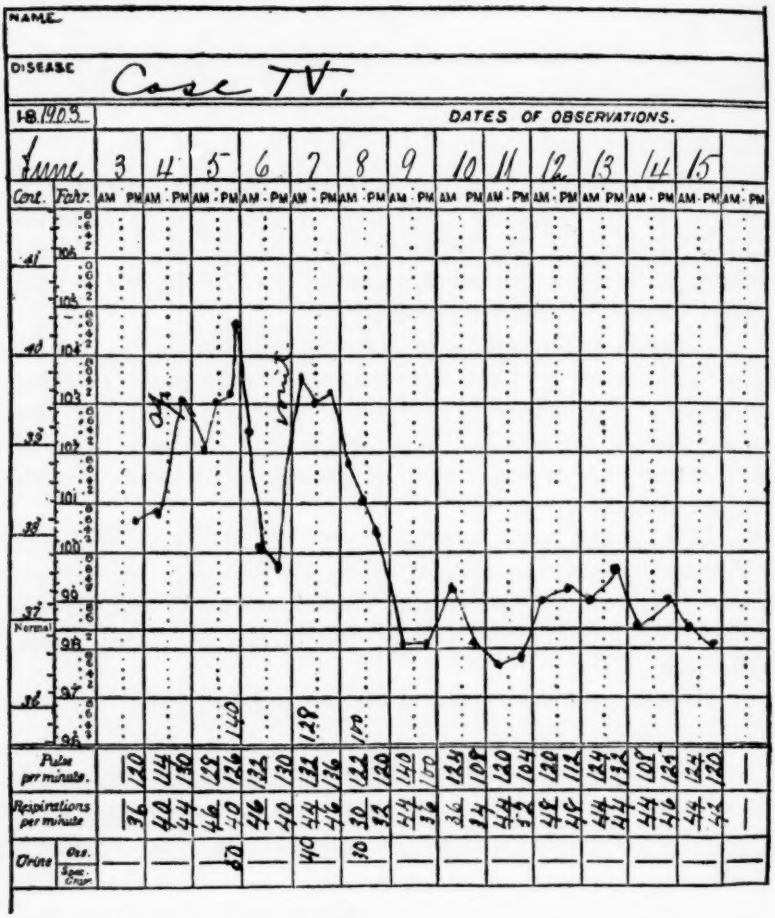
This patient upon admission was not thought very sick. Evidently both pneumonia and peritonitis developed in the hospital. It is not unlikely that they were sequent to a nasopharyngitis, which had given him fever, cough, and nose-bleed before admission.

Pneumococci were found in the peritoneal exudate.

The autopsies in all the cases were made by the writer, as was also the bacteriological examination. Cover-slips were stained by Welch's method and cultures made on Loeffler's tubes.

COMMENTS.—Among the patients were three boys and two girls. The ages were three, three, two and a half, five, and three years. Some variety is shown in the distribution of the peritonitis; once the whole peritoneum was involved, twice chiefly the region of stomach and liver, and twice the hypogastric region. In no case did the patient live to form a localized abscess. All the cases would seem to belong to the diffuse

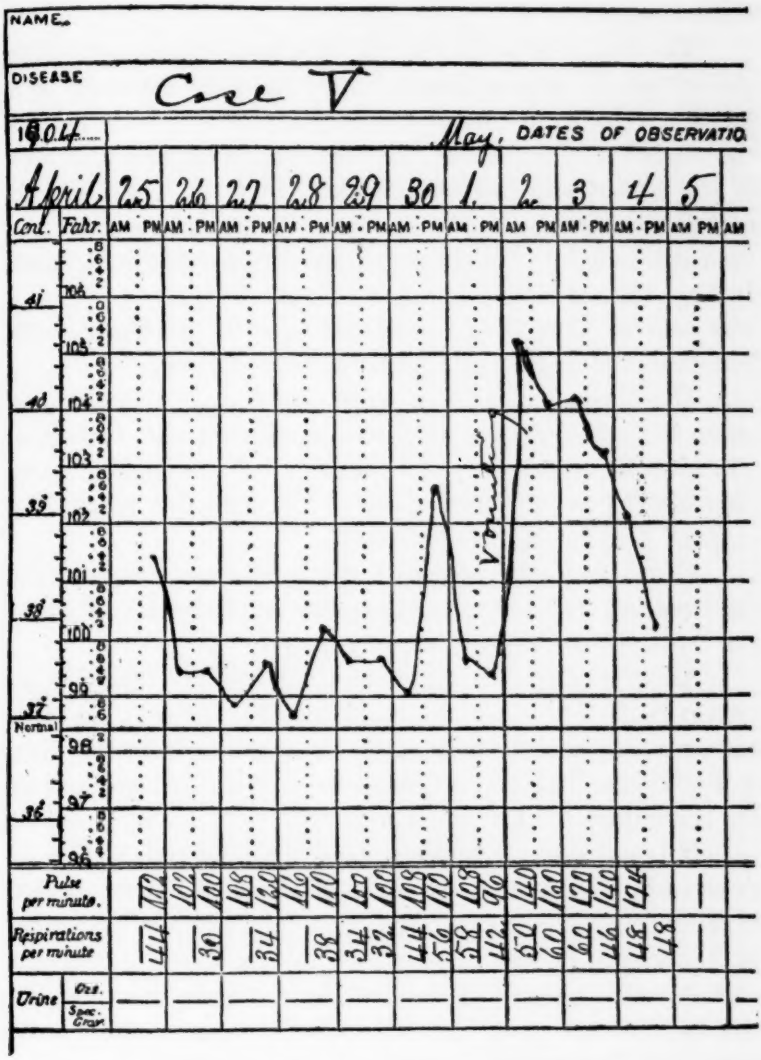
or spreading type of the disease. Four of the patients had empyema. In two the peritonitis followed the empyema, but in another two there is evidence that the process originated at about the same time in the pleura and peritoneum. At the



time of death in these two cases there was but one or two ounces of pus in the pleura. Pericarditis was present once.

Writers have called attention to the rather small percentage of the cases of this type of peritonitis which are associated with pneumonia. This might mean that the primary infection was intestinal or otitic, or that the pneumonia had resolved at

the time when peritonitis was diagnosed. Two of our cases had pneumonia at the time of death.



The deaths in all our cases, except Case IV, have occurred during the first stage of the disease, *i.e.*, the stage of high temperature. In Case IV the death occurred in the second stage,

when the temperature had been practically normal for a week. (See temperature chart.)

Case V shows the steady decline of temperature after the acute onset.

The condition of the bowels in pneumococcus peritonitis strikes one as most unusual. There has been diarrhœa in a large percentage of the reported cases. In four of our cases the condition of the bowels is noted. Case IV had diarrhœa in the second stage of the disease. In Case V the bowels moved satisfactorily with cathartics and enema, and at autopsy the whole length of the colon was found empty and contracted. In Case III the history says bowels moved regularly. Case I was said to have been constipated, but in the hospital the bowels moved as the result of cathartics and enema.

The distention has been much less than in peritonitis or other bacteriology. In no case was there great distention. The histories contain such statements as " abdomen moderately distended," " the abdomen of rickets," " distention relieved by enema," " abdomen not distended."

There has been evidence of pain in all cases, either by the child putting its hand to the abdomen or tenderness to pressure. Flexion of thighs is but once noted.

As to etiology, we can say little definitely. There is no reason to think any case due to intestinal infection. As there has been empyema in four cases and pneumonia in the fifth, it would seem likely that all cases were primarily infections of the respiratory tract.

It is not difficult to understand the fatal termination of these cases when one recalls the multiplicity of lesions, as, for instance, empyema, pericarditis, and peritonitis or empyema, peritonitis and probable meningitis. When we class pneumococcus peritonitis among the less virulent types, we must remember that the cures have been chiefly in cases where peritonitis was apparently primary, and where operation was not undertaken for a generalized process, but for a localized abscess anywhere from two weeks to several months from the beginning of illness. The mortality will always no doubt be

high where there are many pneumococcus lesions, and especially where, as seems likely in some of our cases, the peritonitis is part of a pneumococcus septicæmia.

One will be aided in the diagnosis of pneumococcus peritonitis in the presence of infections of the respiratory tract, if he places most reliance upon abdominal pain and tenderness. One must not rule out peritonitis, because, after the acute onset, temperature begins to subside or the patient seems better.

Peritonitis must be kept in mind so long as there is abdominal pain and tenderness, even though temperature is normal, bowels move regularly, and there is little or no distention.

THE TREATMENT OF THE STUMP IN APPENDICECTOMY.

BASED ON A PATHOLOGIC AND BACTERIOLOGIC STUDY OF THE APPENDIX.

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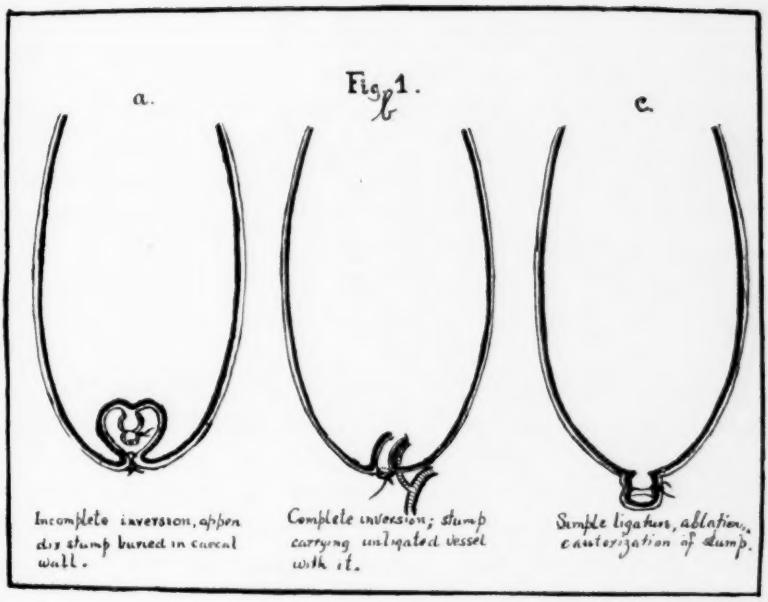
We have innumerable casuistic reports on appendicitis, almost as many detailed descriptions of the anatomy and pathology of the appendix, and a proportionately large number of methods of treating the stump. Yet a careful search of the literature fails to reveal a single article in which the special treatment of the stump is based on definite anatomical, pathological, or experimental data. I therefore undertook to discover if it were not possible by a combination of clinical, experimental, and pathological methods, to determine upon one rational method of dealing with the appendix stump; for surely, unless all the methods are equally good, one of them must be the best, and thus be entitled to a place among the so-called " typical operations."

The result of my investigations is, that simple ligature of the appendix, ablation of the organ distally to the ligature, and cauterization of the stump, is the simplest and safest method of dealing with the diseased vermiform appendix. Dogmatism and surgery do not go hand in hand. There will always be cases where the judgment and ingenuity of the operator must regulate the method of procedure. The appendix may be too friable or gangrenous, or the adhesions may be too dense, to permit of simple ligature and cauterization. Yet, in the main, the fact holds good that, in the ordinary run of both acute and interval appendicitis cases, the most rational method of dealing with the appendix consists in simple ligation, fol-

Fig. 1.


a.
b
c.
Incomplete inversion, appendix stump buried in caecal wall.
Complete inversion; stump carrying unligated vessel with it.
Simple ligature, ablation, cauterization of stump.

lowed by cauterization. Whether the cauterization be done with the actual cautery or with pure carbolic acid makes no material difference. Personally, I prefer the actual cautery, because the heat exerts a bactericidal action at some distance from the point of application of the incandescent platinum, whereas the acid acts only on the surface. Moreover, by dividing the appendix with the cautery one guards against the escape of fæces, and consequent infection of the operation field.

In general, the methods of treating the stump may be grouped under three heads, as follows:

(*a*) Ligation of the base of the appendix, ablation of the organ distally to the ligature, and inversion of the stump by means of Lembert sutures passed through the peritoneum of the cæcum. (Fig. 1, *a*.) In these cases the appendix stump is *inverted into the wall of the cæcum.*

(*b*) Ablation of the organ without previous ligature of its base, and inversion of the stump *into the lumen of the cæcum;* Lembert sutures over the site of inversion. (Fig. 1, *b*.)

(*c*) Simple ligation, ablation of the organ distally to the ligature, and cauterization of the stump. (Fig. 1, *c*.) The disinfected stump is dropped back into the peritoneal cavity.

I shall try to show that both methods, *a* and *b*, are dangerous, and that method *c* is not only free from these dangers, but also possesses distinct advantages.

In method *a* the appendix stump is invaginated into the *cæcal wall.* It is impossible to invaginate it into the cavity of the cæcum, because the base of the appendix has been ligated preliminary to ablation of the organ. A glance at Fig. 1, *a*, will show that we have buried an infected stump in a closed cavity. If the stump has been cauterized, and thus disinfected, before inversion into the cæcal wall, the method is nevertheless a dangerous and unreliable one; for the inevitable exudate that forms is bottled up in a cavity under conditions which are particularly favorable to abscess formation. That such a procedure is likely to lead to serious trouble is not merely an *a priori* deduction, for Herman [1] reports a case from Professor

Rydygier's clinic, where, five days after an interval appendicitis operation, in which the stump was treated thus, an abscess formed in the cæcal wall, perforated into the general peritoneal cavity, and caused death.

Covering the ligated stump with a previously prepared cuff of peritoneum is only a modified way of locking it up in a closed space, and is open to the same objections. Professor Riedel, who, of all the German operators, has been most zealous in his advocacy of American methods of dealing with appendicitis, says: "I consider the suturing of a peritoneal cuff over the appendix stump as a very dangerous procedure. As regards going so far as burying the infected stump in the cæcal wall, this must absolutely lead to perforation into the lumen of the cæcum. If the inverting sutures hold, and the adhesions are strong enough, we need not fear an intraperitoneal rupture, but need only consider the disadvantage resulting from an ulcer in the cæcum as a result of the intracæcal rupture." [2] Riedel draws attention also to the insecurity of this method, in those cases where the cæcal wall is infiltrated and brittle, as it so often is in cases of acute appendicitis.

In method *b* the appendix stump is inverted directly into the lumen of the cæcum. There is therefore no danger of imprisoning a stump exudate, for drainage into the cæcal pouch is complete. We are, however, brought to face two other serious dangers. In this method it is impossible to pass a ligature around the base of the appendix, for such a ligature would prevent complete inversion of the stump. The result is, that for a time at least, the field of operation is in free communication with the infected cavity of the fæces-laden cæcum. Sudsuki [3] has shown that in 57 per cent. of the 500 cases that he examined, the lumen of the appendix contained fæces, and Hansemann [4] goes even farther, saying that fæces are always found in the appendix lumen, irrespective of the presence or absence of Gerlach's valve. On theoretical grounds, therefore, if on no others, it is not advisable or surgical to expose the operative field deliberately to a source of infection, if such a step can be avoided.

This, however, is not the only objection to the complete inversion method. The objection about to be mentioned has, with one exception, never been brought out in surgical literature. I refer to the danger of secondary hæmorrhage. The accounts of the blood supply as given by Nothnagel,[5] Fowler,[6] Deaver,[7] and all the larger hand-books of anatomy, are as follows:

"An anastomosis takes place between the superior mesenteric, ileocolic, right and middle colic arteries by means of arches, from which secondary loops are given off. From one of these secondary loops an appendicular artery arises, in connection with a branch which supplies the cæcal region. The appendicular branch, the essential nutrient artery of the appendix, passes along the free edge of the mesenteriolum, giving off branches to the appendix along the way. In case the mesentery is absent, *the artery passes beneath the peritoneal coat.* In exceptional cases the vessel may pass directly to the tip of the organ, and then be reflected into the submucosa."[8] The anatomic fact that in a fair proportion of cases the appendicular artery runs in the wall of the appendix is one of prime importance, and yet one which has received no clinical recognition, except in an article by Fowler, to be quoted later.

Without stating any reasons or authorities, Murphy, in his most recent article on appendicitis, summarily dismissed as untrue a fact firmly established both by anatomists and surgeons. He says, "The appendix has no vessel running parallel to its long axis; the vessels of the meso-appendix run directly through the mesentery, to the appendix wall."[8] Kelynack[9] states that the mesenteriolum is lacking in a small proportion of cases and is rudimentary in a large proportion. Ferguson,[10] of Toronto, examined 200 cadavers, and found the mesenteriolum absent in 50 per cent. of them. Monks and Blake[11] in 650 autopsies found an absence of the mesenteriolum in 16 per cent. of the cases. In all of these cases the vessel runs in the wall and parallel to the long axis of the appendix, and is caught only by ligating the tube as a whole or by dissecting out the vessel. Yet an essential point in the method of complete

inversion is that no ligature be passed around the appendix. It is for this reason that Fowler characterizes the method as "a brilliant device, lacking the element of safety."[12]

Here, again, clinical facts prove that the danger is a real and not a supposed one. Fowler states:

"The possibility of the existence of a sufficiently large vessel in the wall of the appendix, from which hæmorrhage might occur, suggested itself to me early in the use of Dawbarn's (complete inversion) method, and this was verified by experience later."[12] The case in question had four hæmorrhages of bright red blood (sixteen ounces in all, besides several large clots) which told markedly on the condition of the patient, but which, fortunately, responded to the administration of opium. A careful examination of the rectum failed to reveal any cause for the hæmorrhage, and Fowler concluded that the bleeding came from the appendicular artery.

This is the only case that I can find on record, and yet I have not the slightest doubt that the accident is one of not uncommon occurrence. I myself assisted at an operation followed by similar disagreeable hæmorrhages. The case was operated upon by Dr. Charles Elsberg, at Mt. Sinai Hospital, New York City, and I am indebted to Dr. Elsberg for the notes on the case. The operation was done under local anæsthesia (owing to a mitral valvular lesion). Dawbarn's method of complete inversion of the stump was executed. Twenty-four hours after the operation the patient complained of intense abdominal cramps. An enema was given, and was followed by the expulsion of about eight ounces of bright red blood and numerous clots (no hæmorrhoids or other rectal lesions). The patient gave every evidence of this hæmorrhage, his pulse ranging from 118 to 128. After twenty-four hours of comparative quiet, the cramps again set in, and were again followed by the show of a copious hæmorrhage, followed later in the day by smaller quantities of blood. Under dermatol and opium, with absolute quiet, the hæmorrhages ceased.

Dr. Charles Mayo, of Rochester, Minnesota, kindly sent me the notes of a case similar, in practically all its details, to

the two already quoted, except that he crushed the base of the appendix with an enterotribe before inverting it. The patient, "thirty-six hours after operation, began to pass copious, bright red, bloody stools," as a result of which the pulse-rate ran up to 150 beats to the minute. The symptoms, although alarming for forty-eight hours, finally responded to treatment. Dr. Mayo explained the hæmorrhage on the basis that some branch of the appendicular artery had not been ligated. Hæmostasis is certainly as basic a law of surgery as is asepsis, and on this ground alone it seems to me irrational to execute a method, following which we may encounter a hæmorrhage, in however small a proportion of cases.

Fowler[12] brings to bear even another objection to the method. He states that we are never sure of having inverted the stump into the *lumen* of the cæcum. He thinks that, in a certain number of cases, it is merely crowded in somewhere between the mucous and serous coats of the cæcum, where it may slough and cause a pericæcal abscess. He quotes a case of his, where he inverted the stump into the cæcal lumen, as he thought, but where he found it at autopsy lying between the mucosa and muscularis.

Thus far, then, I have tried to show that incomplete inversion (into the cæcal wall) and complete inversion (into the cæcal lumen) are, in theory and practice, unsurgical procedures. It remains merely to demonstrate that simple ligation of the appendix, ablation distally to the ligature, and cauterization of the stump, is a safe and rational method. In order to show this I shall resort to experimental and clinical proofs, demonstrating that the objections urged against the method are not tenable. And in demonstrating this, I hope to develop facts showing that the method possesses distinct advantages.

One of the main objections to the method is that the ligature forces mucous membrane into apposition with mucous membrane, and that we cannot therefore hope to secure firm union. Morris[13] says: "In ligating an *artery*, opposed surfaces of the tunica intima become adherent; whereas, in an

appendix the opposed surfaces of the mucosa, or of bared lymphoid tissue, do not become adherent," and " the bacteria in the lumen of the appendix are quick to attack the ring of tissue disabled by the compression anæmia, under the ligature, and thus cause perforation." These two statements practically conventionalize one serious arraignment that has been brought against the method of simple ligature and cauterization.

In order to investigate the matter, I ligated various appendices with catgut and silk, and then made serial sections through the ligatured portion parallel to the long axis of the appendix. Invariably I obtained the same picture as shown in Fig. 2, which represents a section taken directly through the centre of a ligated appendix. As may be seen, mucosa is not brought into contact with mucosa, as Dr. Morris states, but is crowded back for fully one-eighth of an inch (viewed macroscopically) on both sides of the ligature, and, moreover, so crowded back as to close off the lumen completely, and thus prevent the germs in the appendicular lumen from attacking the so-called line of " compression anæmia." Moreover, as may be seen, the stump is quadruply fortified, in that it is covered over by (1) the pulpy lymphoid tissue, (2) a thick layer of the resistant submucosa, (3) a layer of muscularis, (4) a layer of serosa, in addition to being shut off by the infolding of the mucosa.

Ochsner [14] rightly remarks that no other tube in the body, so small as the appendix, contains so large an amount of muscular tissue; and it is this excess of muscular tissue which, in part, fortifies our stump. A ligature properly tied around an appendix crushes aside all the coats exactly as does the Doyen enterotribe when applied to the intestine. I can find no record in literature of a microscopical study of the effect of a ligature on the appendix. Rousse [15] studied the effect of a ligature on the Fallopian tube, and found that, when properly applied, the ligature caused almost exactly the same picture that I have described in the case of the appendix. By this means he disproved the contentions of the Fraenkel school, that the tube lumen was not obliterated permanently

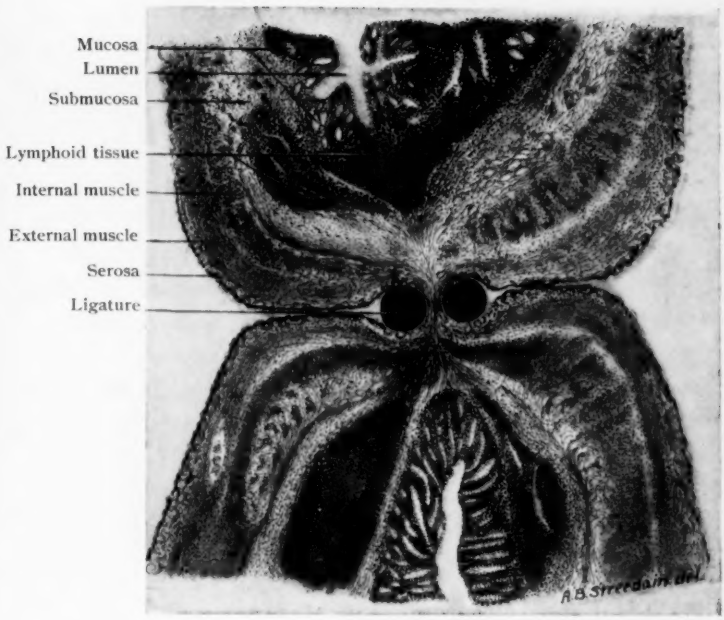


FIG. 2.—Showing the appendicular lumen shut off by the retraction and infolding of the mucosa, and the closure thus formed, protected and reinforced by all the other layers.

by simply ligating it. Lilienthal[16] has described the macroscopical pulpification of the mucosa as the result of a ligature, but the true nature of stump formation is best seen in the microscopical sections.

As regards Morris's statement that perforation occurs after simple ligation of the stump, I can only say that during my two and a half years' interneship at Mt. Sinai Hospital, where we operated upon from 300 to 500 cases of appendicitis a year, I never encountered a perforation in a case where the ligature was applied about an appendix, in a non-gangrenous and not too friable area; moreover, Dr. Howard Lilienthal informs me that this same statement holds good for his twelve years of service as adjunct and attending surgeon to the same institution.

The next serious objection to the method is that it leaves uncovered, in the free peritoneal cavity, an infected stump. In our operative technique, we always disinfect the stump, either with pure carbolic acid or with the actual cautery. In order to ascertain whether these methods secured perfect sterilization, I ligated several appendices and cauterized the stumps with carbolic and the cautery. Dr. Libman, assistant pathologist to Mt. Sinai Hospital, kindly took these appendices in charge. Those that had been treated with carbolic acid he washed in sterile salt solution in order to get rid of any possible excess of the acid, which might otherwise interfere with bacterial growth. After a two weeks' stay in sugar bouillon, the media showed absolutely no growth, and Dr. Libman reported the stumps to be sterile. The argument, therefore, that an *infected* stump is left in the peritoneal cavity does not hold good. Of course, these stumps do pour out a secretion after cauterization, but there is no structure in the human organism better fitted to take care of this secretion than is the peritoneum.

The only remaining argument against the method is, that an uncovered stump leads to the formation of adhesions which so frequently distress the patient after operation. To disprove this statement, I can call to my aid only data collected from

post-mortem findings. I have examined, post-mortem, the cæcum of two patients who had previously been operated upon by the simple ligature and cauterization method for appendicitis. In both instances, that portion of the cæcum where the longitudinal striæ meet to mark the site of the appendix was perfectly smooth and glistening. Nowhere was the original site of the appendix base to be found.

Lilienthal [16] states that an adhesion forms to the cauterized end of the stump, and that as the stump sloughs off this adhesion drags it away from the cæcum. In a personal communication to me, Dr. Lilienthal states that he has examined several cases post-mortem, with the end in view of investigating the question of adhesion formation about the appendix stump after ligature and cauterization. In every case (he confined his examinations only to cases where adhesions did not exist before operation) he found the cæcum free from adhesions, with a small, smooth, dimpled spot to mark the former point of origin of the appendix. One of the cases that he examined had died seventy-two hours after operation, and even in this case the cæcum was perfectly smooth, the site of the appendix being discovered only after a careful search.

We know that the tendency of the peritoneum to form adhesions, displaying itself sometimes in a most erratic fashion, has not been explained by any suitable hypothesis. Presumably, according to Nothnagel,[17] the primary cause of adhesion formation resides in the fact that endothelial cells have been destroyed by trauma or inflammation, and their place taken by connective tissue. According to this theory, simple incision or local inflammation of the peritoneum may lead to the development of localized or widespread adhesions. Nothnagel further says that "adhesive inflammation may be circumscribed to a small area of the peritoneum . . . and may develop from the very outset of a diseased condition of the appendix, the adhesion formation then running a slow and insidious course." If, therefore, the genesis of adhesion formation lies primarily in the appendicular inflammation, it is impossible to claim the assurance for any one method of treat-

ment, that adhesion formation will positively not occur. For example, Eliot[18] reports that after an appendicectomy done by the method I am defending, adhesions formed, causing intestinal obstruction. He therefore forsook the method and adopted the procedure of inverting the stump and covering it with peritoneum. Following this method, however, he reports that he also encountered a case of obstruction due to adhesions around the site of inversion.

The point is, that if adhesions form around the site of inversion, they form to stay and make trouble, whereas, if they attach themselves to a stump which has been ligated tightly enough, their traction on that stump will tend to hasten its separation from the cæcum, thus doing away with the pain consequent upon the pull of the adhesions, and obviating the possibility of intestinal obstruction due to a band.

I have tried to show that the method of simple ligation and cauterization is an absolutely safe one, whereas the other methods are all open to serious criticism both from theoretical and practical view-points. It is not my intention strenuously to contend that there is one, and only one, method of dealing with the appendix stump. There is no cut and dried rule that can be made to fit any one surgical procedure. However, I do feel that it is rational to adopt that method which, possessing all the elements of safety, can yet be more speedily accomplished than all other methods. Saving of time, even though that time be reckoned in minutes, is a great surgical desideratum. My last plea for the simple ligation method is that it undeniably does save time.

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APPENDIX VERMIFORMIS CONCEALED IN THE POSTCÆCAL RETROPERITONEAL SPACE.

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IN view of the scant mention in text-books of surgery and anatomy of the anomalous and rare situation of the appendix in the postcæcal retroperitoneal tissue, and the natural inference that the appendix is congenitally absent if at least part of it is not found intimately covered with peritoneum, this case is of interest.

The clinical history of the case presents no unusual features. S. A. M., dentist, male, single, birthplace and residence in Wisconsin, twenty-five years old; alcohol, tobacco, and venery negative; began in February, 1903, to have attacks of abdominal pain, nausea, tenderness localized over appendix area, and moderate distention of abdomen, with irregularity of bowels. Between attacks, patient tired easily, and did not fully recover his health. When seen first, December 6, 1903, with Dr. J. M. Lewis, of Bloomington, Wisconsin, patient was just recovering from an attack which had been more severe than any previously experienced, during which he vomited once. On examination, the appendix area still gave localized tenderness.

The abdomen was otherwise negative, as was the urine. Diagnosis of chronic catarrhal appendicitis was made and operation recommended, in view of the progressively increasing severity and number of attacks, and the patient's failure to recuperate fully in the intervals. The abdomen was opened by the usual muscle-splitting procedure, and the cæcum identified and brought into the wound. The longitudinal bands and ileocæcal junction were easily made out, but no appendix could be seen. (Fig. 1.) Starting at the point where the longitudinal bands should meet, search was systematically made in all directions for any trace of the appendix, without success. Also there were no signs of

a mesenteriolum. The peritoneum was reflected from a point above the point of junction of the longitudinal bands, without any signs of adhesion or other inflammatory products to the wall of the iliac fossa and neighboring viscera, and presented, except for the high reflection of peritoneum and absence of mesenteriolum, pretty accurately the relations after the removal of an appendix.

The cæcum was next raised at a point four or five inches above its lower end, and with the fingers of the other hand surrounding the gut was carefully drawn up, while the fingers palpating the postcæcal area worked downward. When the lower hand reached a point one-half inch above the ileocæcal junction, a small mass was encountered behind and internal to the cæcum. As I followed this mass towards the middle line and upward, it was found to end in a slight rounded enlargement. Following it downward and outward, behind the cæcum, I brought up at the cæcum, at a point where, if continued, the longitudinal bands would meet. I repeated the procedure of tracing the appendix, and definitely identified it. From a point in the angle of the two anterior longitudinal bands, the peritoneum was incised outward to the fossa wall, and the margins separated. With the end of the cæcum elevated, the appendix was isolated and freed and delivered at the opening of this peritoneal wound. (Figs. 2 and 3.) In freeing it, two small vessels only were tied, and there was almost no bleeding. The direction taken by the appendix, beginning at the cæcum with which it was in close relation throughout, was downward and outward, backward and outward, and making an acute angle turn upward and inward to the end above and internal to the ileocæcal junction. The appendix was easily ligated and removed in the usual way, treating the stump by inverting it, and securing it by a purse-string suture. The second peritoneal wound was then closed by continuous catgut suture and the abdominal wound closed with layer sutures.

The part of the appendix removed on inspection was entirely without peritoneal covering, about three inches long, slender, except at the extremity, where there was slight clubbing, distinctly pale, and anæmic looking. On opening the canal, the proximal third was dilated and presented the usual signs of a chronic catarrhal inflammation, while the rest was obliterated except for a distance of one-quarter inch at the extremity, where

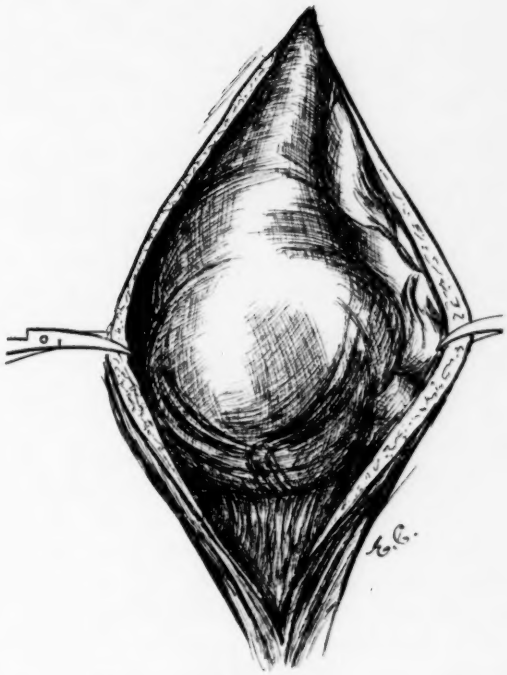

FIG. 1.—Abdomen opened, showing cæcum but no appendix.

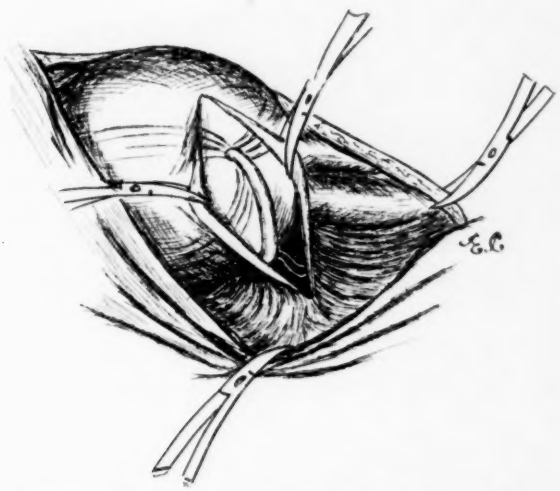

FIG. 2.—Cæcum elevated and visceroparietal peritoneum opened, showing appendix and two small vessels.

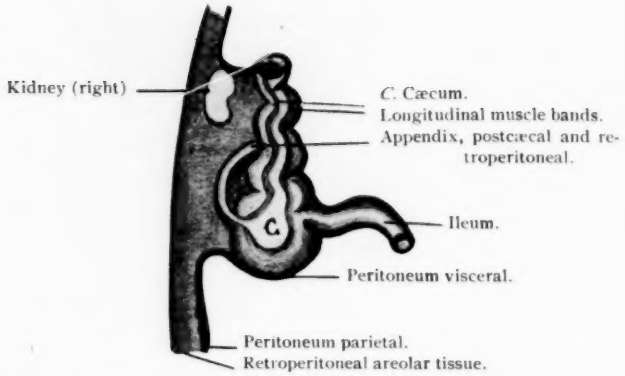

FIG. 3.—Diagrammatic representation of postcæcal retroperitoneal appendix.

dilatation was also present. No concretions were found. Convalescence was satisfactory, and the patient has reported complete relief from symptoms six months after the operation.

In a case of this sort, if one could determine the position of the appendix beforehand, it would not be necessary to open the abdominal cavity to accomplish the removal of the appendix. There seemed to be nothing in the history of the case or the physical signs to point to this anomalous situation.

The importance of investigating the postcæcal region where an appendix is wanting in the usual places is apparent from the history of another patient.

Case 2 was taken ill while travelling in the East, and a diagnosis of appendicitis was made. At operation, an intestinal ulcer and diverticulum were found, but no appendix.

The surgeon thus describes the condition: "In the place of the appendix was a continuation of the longitudinal muscular fibres of the bowel as a mere cord, without any adhesions in the region of the head of the cæcum, which one would naturally look for had the appendix sloughed away." He inclined to the belief that the appendix was congenitally absent. This may be, and likely is, a case of fibrous cord appendix.

In view, however, of Case 1 cited above, and the absence of evidence excluding a postcæcal position of the appendix, the question whether or not there is an appendix in Case 2 will become all important should symptoms suggesting appendicitis arise in the future.

In the literature on the location of the appendix, Treves [1] states that "it frequently lies behind the cæcum," but does not specify its relation to the peritoneum.

Richardson [2] and Cobb state "it is often retrocæcal," but do not specify in regard to the peritoneum.

Further on they say, "The appendix is sometimes situated in a fossa of the peritoneum behind the cæcum," and again, "It is rarely, if ever, absent."

Gray [3] does not mention a retroperitoneal location, but says it may be found in one of the fossæ about the ileocæcal junction.

Quain[4] states "Sometimes it is entirely behind the cæcum, and in this position may be quite free, or firmly bound down to the peritoneum."

"It has a peritoneal fold, the meso-appendix, containing its vessels and nerves and attached to above half the length of the appendix, the distal portion being generally quite free and entirely surrounded by peritoneum."

Monks and Blake,[5] in a critical review of the autopsy findings of 656 cases in which death occurred from other causes than the appendix, report one case in which the appendix lay "behind peritoneum under cæcum, and extended upward to lower border of right kidney."

McBurney[6] states "The appendix is normally an intraperitoneal organ, except in those cases in which very early adhesion and obliteration of the contiguous peritoneal coverings of the colon and the posterior abdominal wall will have occurred." "It may lie behind the cæcum, or even in the retroperitoneal tissue behind the cæcum, as has been mentioned."

Parker[7] examined seventy appendices in the dissecting-room, and does not speak of a retroperitoneal position.

Boas,[8] citing Bardeleben, Luschka, Tuffier, Maurin, Bryant, and F. von Sydow, says that in more than 96 per cent. of all cases the appendix lies intraperitoneally.

Hartley[9] cites Ferguson's report of seventy-seven out of 200 cases as "having the peritoneum so disposed as to allow an immediate involvement of the subperitoneal tissue by its perforation."

Maurin reports (Hartley) all of his cases as being completely surrounded by peritoneum. He also quotes Kelynack as asserting that all his cases showed the appendix to be "a truly intraperitoneal organ." Further, Hartley gives it as his opinion "That some of these cases reported as being extraperitoneally placed appendices are only appendices herniated into some of the fossæ at the junction of the ilium and cæcum, or are partly intra- and extraperitoneally placed."

Reviewing the literature as indicated in the Index Medi-

cus and Bibliographia Medica, as far back as the time of publication of Monks and Blakes's article mentioned above, I found no reference to this situation of the appendix. More recently V. Bergmann [10] mentions this anomaly as a possibility.

In view of the absence of inflammatory signs, absence of mesenteriolum, the situation of the appendix as described, and the condition of the appendix as found upon removal, it seems clear we have to deal with a congenital anomaly of position of the appendix. The explanation of the condition, concurred in by Professor Thomas Dwight in a personal communication, is to be sought in the development of the intestinal tract and peritoneum.

Originally in the embryo, the intestine is freely movable and covered by peritoneum, and as the appendix develops from the cæcum it too is covered by peritoneum. Later, during development, certain parts, among which is the ascending colon and sometimes the cæcum, in varying extent, become attached behind by the adhesion and obliteration of the apposing peritoneal surfaces—visceral and parietal.

It is not uncommon to see the upper posterior surface of the cæcum adherent to the posterior abdominal wall, and in the case of a retroperitoneal appendix this process of adhesion and obliteration of apposing peritoneal surfaces has, during development, extended beyond normal limits to such a degree as to involve the appendix by inclusion and obliteration of its peritoneal covering.

Under the circumstances, the mesentery of the appendix also disappears, and its vessels are to be found in the retroperitoneal areolar tissue.

Aside from its anatomical interest, the retroperitoneal appendix may in any individual case have a surgical importance, from the fact that complete congenital absence of the appendix is, indeed, rare; and if one does not at operation readily find the appendix in the abdominal cavity or herniated in the fossæ about the cæcum and ileocæcal junction, one should not conclude that the viscus is absent, until a thorough

and careful search has been made of the postcæcal retroperitoneal region.

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REMARKS ON APPENDICITIS.

BASED ON AN ANALYSIS OF 219 CASES OPERATED UPON AT LEBANON HOSPITAL UP TO APRIL 1, 1904.

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If one need to make an apology for bringing the subject of appendicitis before the Surgical Society, ours will be the fact that our experience has ever added to our own knowledge, and therefore we feel that a review of a considerable number of cases may aid in the study of this disease, and also the fact that it seems to us well to carefully consider certain propositions regarding the treatment of appendicitis, notably the method of operating, and the question as to whether to operate or not in acute cases at or near the time when perforation has taken place.

The 219 cases herewith analyzed may be classified as follows:

	Cases.	Deaths.
Class 1. Chronic, recurrent, relapsing; interval operation ...	43	0
Class 2. Acute, including perforative, gangrenous, suppurative, local, and more or less diffuse peritonitis	157	7 (*i.e.*, 4.4 per cent.)
Class 3. Fulminating, and cases with general septic peritonitis diagnosticated prior to operation. Many of the cases were practically moribund	19	19 (mortality, 100 per cent.)
Total	219	26 (12 per cent.)

		Cases.	Deaths.
Cases operated on by Dr. Syms.	Class 1	27	0
" " " " "	Class 2	44	1 (2.2 per cent.)
" " " " "	Class 3	4	4 (100 per cent.)
Total		75	5 (6.6 per cent.)

		Cases.	Deaths.
Cases operated on by Assistants.*	Class 1	16	0
" " " "	Class 2	113	6 (5.3 per cent.)
" " " "	Class 3	15	15 (100 per cent.)
Total		144	21 (14.5 per cent.)

We were very much surprised at the view expressed by Ochsner, namely, that cases of acute appendicitis should not be operated upon after the twelfth to twenty-fourth hour, until resolution had apparently taken place and the case could be treated as an interval one, or until a large perityphilitic abscess had formed which might be opened by the extraperitoneal incision, years ago known as the Parker incision. The treatment proposed by Ochsner is more or less generally known as the starvation treatment, consisting of lavage of the stomach and otherwise absolute rest of the stomach and upper intestinal tract, nourishment being supplied by rectal alimentation entirely. For this method of treatment Ochsner claims great things, and he has attracted many advocates to it. But it seems to us that a review of the cases here presented would show that it would be applicable alone to the cases of general septic peritonitis, which we believe to be fatal in practically 100 per cent. when operated upon.

The cases of chronic, recurrent, relapsing appendicitis, known as interval cases, have presented no deaths in our experience, and we believe it reasonable to expect that a clear record should be obtained, certainly when ideal surgery can be performed. If cases of general septic peritonitis are to be considered universally fatal, it would leave for our consideration that list of cases included under Class 2, *i.e.*, acute perforative, gangrenous, suppurative appendicitis with localized abscess,

* We wish to thank our co-workers, the Assistant Attending Surgeons to the Hospital, Drs. Henry Roth and William Shufelt, for their valued and skilful co-operation. It is but fair to state that they operated on a large proportion of cases that came in at night, or that, on account of their urgency, had to be operated upon at odd times, and therefore they probably encountered cases of more severity than occurred in the author's list.

localized or diffused peritonitis, but not general peritonitis nor general peritoneal sepsis. Of these cases we have lost one in this series of forty-four cases (2.2 per cent.), and our assistants, out of 113 cases, have lost six, making a total of seven, or 4.4 per cent. Of these 157 cases it would be impossible to conceive that anything like so small a death-rate could have obtained had the expectant or starvation treatment been pursued. They embraced cases in which the gangrenous appendix lay free in the abdomen, and where general peritoneal sepsis would have been inevitable but for operative interference. There were cases of peri-appendicular abscess with adhesions more or less firm, but in a proportion of which it would be fair to suppose that general infection would have taken place save for the relief given by operation. There were cases in which there was gangrene of the omentum, gangrene of the cæcum, perforation of the bowel, beside perforation of the appendix; and it is impossible for us to believe that more than a small majority of these cases could possibly have survived an expectant treatment, and those only by some such lame process of nature as spontaneous opening of an abscess externally or into one of the hollow organs of the abdomen. When one considers such a series of cases as reported by Ochsner, one must take for granted the accurate diagnosis, for the conditions were not seen and could only be surmised; and we think any surgeon must concede that to make an accurate diagnosis of the intra-abdominal condition in cases of suppurative inflammation is impossible. All Ochsner's cases lacked the accurate knowledge which is obtained by operation.

It seems to us that such a plan of treatment as applied to this class of cases must merely mean the survival of the fittest. We all recognize the fact that a patient on the eighth, tenth, or twentieth day after the initial stage of an appendicitis is comparatively safe, if he be alive; but we must not lose sight of the fact that he passed through a period of danger before reaching this stage, and that many who have tried to do likewise have died.

It is the theory of Ochsner and those who hold with him,

that operation is extremely dangerous at the period when perforation of an appendix has taken place, and we agree that such operation is dangerous unless performed with the utmost care. We also maintain that the ideal of surgery and of medicine is that we should not have cases come to operation at this period, for every case of appendicitis, if properly and carefully observed, should come to operation before this period is reached. But when the surgeon finds his patient at his first visit in this condition with an appendix ruptured, with a localized peritonitis, or a localized abscess, there is no opportunity for him to choose, if he believes as we do; and he must then operate; but he must so operate that the operation shall not present as high a degree of mortality as would the expectant treatment in these cases.

At the meeting of the American Medical Association in 1902 we reported our nine fatal cases of appendicitis. These were the only cases of death from operation in our series dating from the year 1888. Unfortunately, we are unable to present the full number of cases, so that we cannot give the percentage, but suffice it to say that in all our experience we have had but two deaths among patients belonging to Class 2, namely, acute perforative, gangrenous, suppurative appendicitis with localized abscess, localized or diffused peritonitis. (In the cases here reported our one death represents but 2.2 per cent.) Ochsner states that operation at this period has a death-rate of 20 per cent. We have lost but 2.2 per cent. as shown above. And we believe this small percentage is owing to the method of operating.

We wish to lay stress on the proper manner of operating upon cases embraced under the Class 2. Unfortunately, the statement has been many times made, and is too often acted upon, that the peritoneum is capable of safely dealing with a surprising amount of infection or of infective material; for the ideal surgical procedure is the one which does not subject uninvaded peritoneum to any infection whatsoever. Our endeavor in operating on these cases has been to thoroughly

protect the uninvaded peritoneum from infective material by the most careful and thorough gauze sponging or packing.

Peri-appendicular abscesses are opened in a systematic manner. After the field has been thoroughly exposed, and the point for entrance of the abscess chosen, with the region thoroughly walled off by sponges, the abscess is opened by separating adhesions very gently, and the first escape of pus is controlled by the pressure of the finger of the operator over the opening. From then on the operator uses small marine sponges held in forceps, which are passed like a series of buckets at a fire. As soon as a sponge is lifted from the opening it is replaced by another, and all of the pus is absorbed in these sponges, none of it being allowed to escape into the wound. After the tension is removed from the abscess, the opening is carefully enlarged and the evacuation can take place more rapidly. Finally, the abscess cavity is emptied, and the surface cleansed with peroxide of hydrogen (which we feel will destroy pus, but which will not disinfect tissue). In almost all cases nowadays we continue the separation of adhesions to the point of removing the appendix; but we do not in the least agree with those who claim that it is safe to evacuate pus into the peritoneal cavity, and then rely upon disinfection with hydrogen dioxide, or any other means; nor with the opinion that, having removed the diseased appendix, no matter how, the peritoneum will be able to take care of whatever infection may have been superinduced. The operation is completed by careful and thorough packing of the wound with gauze for the purpose of drainage. This packing is so placed as to keep the intestines well within the abdomen and to keep healthy intestine from contamination with the already infected area. In some cases we use rubber tissue and gauze, but when the infective process has been a severe one we use gauze alone. If this packing is properly done, it will never cause intestinal obstruction; but if the pads of gauze are placed between the folds of intestine it will frequently be productive of trouble. Before leaving this phase of the subject, we would submit that in these recorded cases our mortality of 2.2 per cent., and in

all of our other appendix operations,—number not known,—our single death in this class of cases is a better record than we could have obtained by the expectant plan of treatment.

When one comes to the question of cases of general septic peritonitis, which our experience has presented a mortality of 100 per cent., when operated upon, one should welcome with joy any plan of treatment recognized as proper which will relieve the surgeon from the responsibility of operating, and which will relieve the community and the public at large from the great disadvantage that they are put to by every case of appendicitis that dies following an operation. When one considers the greatest good to the greatest number, it must be conceded that each case of appendicitis dying without operation is a great benefit to the public, while every case of appendicitis dying after operation is a public calamity. We have always held that in the history of every case of appendicitis there has been a period when that case could and should have been operated upon safely and successfully. In other words, ideally speaking, there should be absolutely no mortality rate from appendicitis.

Some time ago, expressing this view to a colleague, the latter cited the instance of a patient whom he had recently seen, who was operated upon within seven hours of the first symptom of appendicitis, and yet it was found that his appendix was gangrenous, and there was general peritoneal sepsis, from which the patient died. But we maintain that this was not within seven hours of the first symptom, and asked our friend if it was not at least ten years after the first symptom, and on further inquiry it was found that for years the patient had suffered from well-marked symptoms of appendicitis, such as slight localized tenderness, slight localized pain, chronic indigestion, abdominal distention, and that train of symptoms which should either be cured by the general practitioner or which should lead him to turn the patient over to the surgeon.

Among the nineteen cases belonging to Class 3, viz. (general septic peritonitis), which died, many were almost moribund at the time of operation. These were not by any

means all cases of fulminating appendicitis, but many of them had belonged to Class 2, and had passed from that more favorable condition during days of unnecessary delay before they had been brought to the hospital. Feeling the confidence which we do in Ochsner, and having the conviction that operation in these cases will result in no good, we would gladly place all these cases on the starvation plan of treatment, but for the fact that no one can be positive of the diagnosis. A number of our cases which we have saved have apparently been cases of general peritonitis, seeming so to be even when the abdomen was opened; but the very rapid benefit following operation has proved to us that they were not cases of general peritonitis, but that they really belonged to Class 2. We feel that there is a great distinction to be made between cases of diffuse peritonitis and cases of general peritonitis. To find the abdomen full of seropurulent material is not enough to establish the diagnosis of general peritonitis, and we feel convinced that general peritonitis is necessarily a fatal condition. Our method of dealing with these cases, where the disease is not walled in nor localized by adhesions, is to remove the diseased appendix and any gangrenous mesentery or omentum, to cleanse the local field with hydrogen peroxide, and to mop out the excessive excretion. We no longer resort to flushing in any cases, and we do not use wide-spread gauze packing in the abdomen, but attempt merely to thoroughly pack the original site of the disease in a way that will drain it.

When one comes to a patient who can evidently withstand the operation, but in whom the chances of recovery seem to be but the slightest, one is confronted with perhaps the most difficult question which presents itself in surgery; that is to say, whether to operate or not. But from the patient's point of view, the slight chance of recovery by operation is the only chance he has; and it certainly seems that the question becomes a moral one, and that the patient is entitled to this one chance, and that the surgeon should not shirk the responsibility. But we always look with longing and regret to those precious hours which have been lost by delay, and to that period that has

existed in every patient's case when he might have been operated upon with no fear of a fatal result. So far, we have operated upon every case which has been admitted to Lebanon Hospital except one. He was really moribund, and died a few hours after admission.

In closing, we would like to express the deep sorrow and mortification we feel at the apparent lack of knowledge, or appreciation of the danger of appendicitis, on the part of many physicians. At Lebanon Hospital we are constantly admitting patients who are in a precarious condition, owing to the fact that their physicians have kept them from operation day after day, apparently not recognizing the gravity of the case,—certainly not through inherent ignorance, but it must be on account of lack of careful investigation of the cases. It is pitiable at the time of operation—perhaps on the seventh or eighth day—to find a hopeless condition which surely did not exist at a period long after the disease should have been thoroughly recognized, and when operation could have been expediently and safely performed. Fortunately, this deplorable mistake is being made with ever decreasing frequency, and we should all look forward with hope to the time when the public and physicians will recognize the fact that appendicitis is absolutely a surgical and not a medical disease.

DOUBLE TRAUMATIC ILIAC DISLOCATION OF THE HIP.

REPORT OF A RECENT CASE, WITH A REVIEW OF THE LITERATURE OF THE SUBJECT.

BY JAMES H. LEWIS, M.D.,

OF BUFFALO,

Resident Surgeon to the Moses Taylor Hospital.

(*From the Surgical Service of Dr. Wainwright.*)

THE rarity of double traumatic dislocation of the hip seems to justify the report of the following case from the Moses Taylor Hospital in Scranton.

E. E.; eighteen years old; driver in coal-mine; has always had good health, and has had no previous injury or disability of either hip. On May 11, 1904, two hours before admission to the hospital, as he was riding on the bumper of a loaded coal-car, he was thrown by a sudden jolt upon his hands and knees directly in front of the car, which then struck him in the sacral region. He managed to drag himself from beneath the car by means of the mule traces. He was brought to the hospital by an ambulance, and on examination the typical signs of double iliac dislocation of the hip were evident. The great trochanter on each side was three inches above the Nélaton-Roser line with the head of the bone plainly palpable on the dorsum of the ilium. There were also contusions over the sacrum and an abrasion of the right knee. Further examination was negative. Under ether both sides were easily reduced by Bigelow's method. The knees were bandaged together and no other retentive dressing applied. The patient was confined to bed for four and one-half weeks. At the end of this time he could walk with no pain or disability in the hips. Movements in the hips, measurements, and the relations of the bony prominences were normal. There was, however, foot-drop on the right side, due presumably to pressure of the

knee bandage on the external popliteal nerve as it winds around the head of the fibula. This foot-drop rapidly cleared up.

Stimson says that, compared with other injuries, dislocations are infrequent,—the proportion to fractures being about one to ten. In his series of 705 recent traumatic dislocations seen at the Hudson Street Hospital, New York, from 1894 to 1899, there were nine of the hip. Kroenlein, in 400 dislocations, saw eight of the hip. Kneer tabulated 1068 dislocations, 9.5 per cent. being of the hip. This percentage is high, as ambulatory cases were not included. Billroth, in his clinic, 1860 to 1876, saw fifteen cases of hip dislocation, and Weber, in thirty-eight years at Bonn, saw twenty-two. Kroenlein gives 2 per cent. as the number of dislocations referable to the hip. Of the above authors, only one, Kroenlein, reported a double dislocation of the hip.

In 1887, Niehans (*Deutsche Zeitschrift für Chirurgie,* Vol. xxvii) collected twenty-five cases of double dislocation of the hip and added one of his own.

In 1891, Six (Wurtzburg Thesis) found three more cases, and reported one of his own. A careful review of the literature up to the present time has revealed only one other case. This was reported by Pfeiffer in 1887 (*Boston Medical and Surgical Journal,* 1887). This with our own case makes a total of thirty-two recorded. The rarity of cases in the literature of the past few years may in part be due to the fact that operative surgery has to a large extent diverted attention from non-operative injuries.

It is seldom that the account of the exact manner of the accident is clear enough for one to draw a definite conclusion as to the mechanism by which these severe dislocations occur. It generally seems, however, that the force is applied while the thighs are in flexion, as was the case with the present patient.

Twenty-five of the cases were young or middle-aged men, one was a woman and two were children. Where the result is stated, reduction was accomplished in twenty-three cases. Four remained unreduced and two cases died. One death

(Niehans) was from shock after resection of one side, and the other (Six) from shock after a successful reduction of both sides.

There were six cases, including the present, of the double iliac variety. Of these only three were reduced. These cases in detail were as follows:

CASE I.—WOOD. Man, 46 years old; had double posterior dislocation since a fall at six years of age. No reduction.

CASE II.—PRITCHARD. Man, nineteen years old; railroad employee. While working in a stooping position on the track was knocked down. Reduction easy.

CASE III.—Catalogue of Pathological Cabinet, New York Hospital, 1860, No. 31. Man, twenty-seven years old; quarry-worker; injured in a premature explosion. Arm badly torn, of which he died at seventh month. Hips not reduced. This patient said the trouble with the left hip was congenital. It would seem that this case should be excluded. (It has, however, been counted among these cases by Niehans and Six.)

CASE IV.—LIEBL. Fireman, twenty-five years old; was thrown against a solid body by a forward movement of his engine. Considerable shock and local blood effusion. Attempt at reduction sometime later under ether failed. Resection four months after injury, with death two days later in collapse .

CASE VI.—Present case.

Inasmuch as Six's table appeared thirteen years ago, and is very inaccessible in this country, we reproduce it here, with the addition of Pfeiffer's case and our own.

SIX'S TABLE OF DOUBLE TRAUMATIC DISLOCATION OF HIP.

No.	Reporter.	Date.	Age.	Sex.	Right.	Left.	Therapy.	Result.
1	Singowitz.	1830	?	Man.	Obturator.	Obturator.	Reduction.	Recovery.
2	Andreini.	1845	30	Man.	Iliac.	Infrapubic.	Reduction.	Recovery.
3	Jung.	1846	30	Man.	Ischiadic.	Iliac.	Reduction.	Recovery.
4	Bruns, Kneer.	1851	50	Man.	Iliac.	Iliac.	Reduction tried.	Failed.
5	Kirn.	?	?	Woman.	Obturator.	Iliac.	Operation.	Recovery.
6	Wood.	1852	46	Man.	Iliac.	Iliac.	No treatment.	Unchanged.
7	Barker.	1854	19	Man.	Obturator.	Obturator.	Reduced.	Recovery.
8	Pritchard.	1854	19	Man.	Iliac.	Iliac.	Reduced.	Recovery.
9	Hodgen.	1855	?	Boy.	Ischiadic.	Obturator.	Reduced.	Recovery.
10	Warren.	1857	?	Man.	Obturator.	Iliac.	Reduced.	Recovery.
11	Bowrienne.	1857	35	Man.	Ischiadic.	Iliac.	Reduced.	Recovery.
12	New York Hospital Pathological Cabinet.	1860	27	Man.	Iliac.	Iliac.	Reduction tried.	Failed.
13	Boisnot.	1867	40	Man.	Pubic.	Iliac.	Reduced.	Recovery.
14	Fischer.	1868	37	Man.	Iliac.	Ischiadic.	Reduction tried.	Failed.
15	Steiner.	1869	29	Man.	Obturator.	Obturator.	Reduced.	Recovery.
16	Pollard.	1872	53	Man.	Obturator.	Iliac.	Reduced.	Recovery.
17	Kunschert.	1874	?	Man.	?	?	Reduced.	Recovery.
18	Crawford.	1876	30	Man.	Iliac.	Ischiadic.	Reduced.	Recovery.
19	Packard.	1878	40	Man.	Obturator.	Iliac.	Reduced.	Recovery.
20	Allis.	1897	42	Man.	Iliac.	Obturator.	*	
21	Schinzinger.	1879	40	Man.	Ischiadic.	Pubic.	Reduced.	Recovery.
22	Roberts.	1880	65	Man.	Iliac.	Obturator.	Reduced.	Recovery.
23	Niehans.	1881	25	Man.	Iliac.	Iliac.	Resection (right).	Death.
24	James.	1883	44	Man.	Obturator.	Iliac.	Reduced.	Recovery.
25	Liebl.	1883	?	Man.	Iliac.	Iliac.	Reduced.	Recovery.
26	Ebner.	1883	18	Man.	Obturator.	Obturator.	Reduced.	Recovery.
27	Kroenlein.	?	?	?	Pelvic.	Pelvic.	?	?
28	Gibson.	?	?	?	?	?	?	?
29	Cooper.	?	?	?	?	?	?	?
30	Pfeiffer.	1887	8	Girl.	Iliac.	Ischiadic.	Reduced.	Recovery.
31	Six, Schonborn.	1891	27	Man.	Ischiadic.	Iliac.	Reduced.	Death.
32	Lewis.	1904	18	Man.	Iliac.	Iliac.	Reduced.	Recovery.

* Right side reduced by De Forest Willard. On left side reduction tried, but failed. Dr. Willard kindly traced this case in July, 1904. He found the right hip normal. The left femoral head was still on the obturator foramen. The patient walks very comfortably, but with a limp. He attends regularly to his daily duties. This accident occurred in 1879.

FRACTURE OF THE TIBIAL TUBERCLE.

BY MARTIN W. WARE, M.D.,

OF NEW YORK,

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A DESCRIPTION of this fracture, which it has been my rare fortune to encounter, is found wanting in the text-books of surgery and special treatises on fractures. A search of the current literature, however, has brought to light a few cases which corroborate the findings in my case.

The history is as follows: E. H., aged sixteen years, was suspending his body-weight in the vertical position while swinging on rings. He suddenly let go his grasp and, in falling to the ground, landed on his feet; his knees gave way under him and he fell on his back, unable to rise thereafter.

He was seen six hours after the injury. His right knee was swollen and discolored. The dimple normally located on either side of the ligamentum patellæ was obliterated, and there was a slight discoloration visible. The limb was in the semiflexed position and extension voluntarily was impossible. Upon placing the hand over the knee, crepitus was at once perceptible. The tubercle of the tibia was movable, and when brought down upon the head of the tibia, crepitus could be elicited. Dancing of the patella could easily be made out.

Treatment.—The fragment, so readily replaceable, was held in place by zinc oxide plaster, and over this a plaster cast was moulded to the limb, and absolute rest was enjoined. The cast remained on two weeks, and was again replaced for another two weeks. At the expiration of this time union was firm, but a large callus was visible at the site of the fracture. There was some stiffness. It took several months thereafter for the limb to regain its function.

The diagnosis was confirmed by a skiagraph, of which an illustration (Fig. 1) is appended.

The accompanying illustration (Fig. 2), according to Poland,[1] shows the tubercle to have an occasional separate centre of ossification, which eventually joins the upper epiphysis at the age of sixteen to eighteen; but, as a rule, the tubercle ossifies by extension downward of the upper epiphysis. When, therefore, a separate centre of ossification is at hand, we may speak of a true epiphyseal separation, but, as a rule, fracture exists. A communication of the synovial bursa under the ligamentum patellæ with that of the knee-joint is often present (Quain), in consequence of which an effusion into the knee-joint may be expected.

Poland (*Loc. cit.*) records ten cases, in all of which indirect violence was responsible for the injury, but in the majority of instances crepitus was absent.

Osgood's [2] experience in the main substantiates the observations of Poland.

In agreement with the above-mentioned authors, Schlatter,[3] who has most recently contributed to this subject, cites the right side as being most frequently affected, but refers to direct violence as responsible for a number of fractures. In his seven cases the knee-joint was not the seat of an effusion, and he thinks this only obtains if the whole epiphysis is torn off.

The treatment advocated by all is extension in plaster of Paris.

As to prognosis, Poland (*Loc. cit.*) says the result differs from fracture of the patella, inasmuch as osseous union may always be expected if the fragments are brought into apposition.

On the other hand, Schlatter (*Loc. cit.*) says the nearer the age of the patient approaches the period of adolescence, the less the time required for healing. In two cases it took all of two years before healing was completed.

Like in my own case, the healing of the recorded cases in each instance was followed by marked callus formation.

Bearing on this point, I wish in conclusion to refer to an affection of the tubercles of each tibia incident to direct violence inflicted on these structures due to a fall upon the knees. Tem-

FIG. 1.—Fracture of tibial tubercle.

FIG. 2.—The centres of ossification forming the head of the tibia. (Poland.)

porarily incapacitated for walking and without any medical advice, functional activity of the knee-joints was restored, but a marked increase in the size of each of the tubercles was manifest ever thereafter. This case presented itself before the advent of the X-rays, and the diagnosis could only be tentatively made.

All of the fractures of the tibial tubercle occurred in males, but O'Donoghue [4] records one in the case of a female.

LITERATURE.

[1] Poland. Traumatic Separation of the Epiphyses, 1901.
[3] Osgood. Lesions of the Tibial Tubercle occurring during Adolescence. Boston Medical and Surgical Journal, Vol. cxlviii, No. 5.
[3] Schlatter. Verletzungen des Schnabel foermigen Fortzatses der Oberen Tibia-Epiphyse. Bruns klinische Beitr., Vol xxxviii, Heft 3.
[4] O'Donoghue. Avulsion of the Tibial Tubercle. Boston Medical and Surgical Journal, June 11, 1903.

ABDOMINAL CRISES CAUSED BY MECKEL'S DIVERTICULUM.

REPORT OF TWO RECENT CASES, WITH A REVIEW OF THE LITERATURE OF THE SUBJECT.

BY OLIVER C. SMITH, M.D.,

OF HARTFORD, CONN.

CASE I.—F. P., a fairly healthy child, ten years of age, on the evening of May 28, 1904, was suddenly taken with vomiting and severe pain in the right lower abdomen. Patient was seen by me in consultation with Dr. E. O. Elmer at 1 P.M., May 29. At that time the child had the appearance of commencing general peritonitis. An anxious countenance, abdominal dyspnœa. Pulse, 120; rectal temperature, 102.5° F. Abdomen presented general tympanitic distention. Right rectus very rigid. Marked tenderness over McBurney point. The bowels had been moved by calomel and enema. Heart and lungs normal, save coarse bronchial râles. Kidneys secreting freely. No bladder irritation. Diagnosis, acute appendicitis with probable perforation. Leucocyte count not made. Operation under chloroform anæsthesia at 5 P. M. One hundred cubic centimetres of sanguinopurulent serum escaped upon incising the peritoneum. A dense, round mass was felt directly under the incision. This proved to be, not the appendix, but a distended, inflamed, and *perforated* Meckel's diverticulum. A small quantity of bile-stained fæces was escaping from the perforation, which was near the attachment to the ileum. The omentum was adherent to the distal end of the diverticulum. Plaques of lymphatic exudate marked the efforts of nature in walling off the destructive process. The intestine was purse-stringed, with No. 2 chromic gut, one-half centimetre from its junction with diverticulum. The latter was clamped and severed, and the intestine turned in, as is commonly done in dealing with the stump of an appendix. The diverticulum was three to four centimetres in length and two centimetres in diameter. Its mucosa was deeply engorged and bulging into the perforation. Apparently but a small amount of fæces had escaped into the abdominal

cavity. The mesenteric glands were enlarged in either direction from the seat of the disease. The appendix, which was found deep in the right iliac fossa, was brought up with difficulty, as the cæcum was closely attached to the pelvic wall. It was found sharply bent upon itself, with thin adhesions attaching its proximal third to the intestine. Upon opening it after removal, it was found to have a normal mucosa at either end, but contained a catarrhal secretion in the middle third. The abdomen was lightly drained; there was but slight shock, and the patient made an uneventful recovery.

CASE II.—K. B., male, aged nineteen years. Personal history negative, until June, 1903, when a short attack of intestinal obstruction occurred, accompanied with vomiting and severe pain. The condition was relieved by high enemata.

September 20, 1903, he was seized with a similar attack late in the evening, following an indigestible meal. High enemata were unavailing. A hypodermatic injection of one-quarter grain of morphine, repeated within an hour, failed to control pain. Peristalsis was constant. Vomiting occurred at frequent intervals, the patient remaining on his hands and knees in great distress. The abdomen was considerably distended, and the recti muscles were rigid. The most marked point of tenderness was two centimetres below and one centimetre to the right of the umbilicus. Lavage of stomach and laparotomy performed eighteen hours after onset. Incision through right rectus below umbilicus. About 100 cubic centimetres blood-stained serum escaped upon opening the peritoneal cavity. Two coils of ileum were found constricted; the constriction being due to a twisting of the bowel around a diverticulum, extending from a point on the ileum eighteen inches above the ileocæcal valve to the left pelvic wall. This diverticulum was also twisted upon itself to the point of obstruction, the distal end being distended and of a deep color. The diverticulum was excised between ligatures, its base at the proximal end being inverted into the intestine and closed by purse-string suture. The appendix vermiformis, which was found congested, was removed. Towels wrung out of hot salt solution were applied to the injured intestines, their normal color gradually returning. The patient reacted well, and the vomiting and pain gradually subsided. Bowels moved on the third day. Primary union. Uneventful recovery.

The literature on the subject of intestinal crises caused by Meckel's diverticulum is meagre.

Cases of intestinal obstruction similar to my second case have of late years been not infrequently observed, but instances of acute inflammatory, gangrenous, and perforative diseases of the diverticulum similar to my first case are decidedly rare.

Dr. William Perrin Nicholson, of Atlanta, Georgia, reported such a case in the *New York Medical Journal* of June 23, 1900. His case was operated upon on the third day, and, while vomiting ceased and some improvement followed the operation, the patient died eighteen hours later. Autopsy showed the diverticulum had caused no mechanical constriction, and the intestinal obstruction was due to the inflammatory process about the gangrenous diverticulum. Dr. Nicholson at this time collected reports of six cases. Two of these were reported by Dr. Richardson, of Boston, one of which was saved by operation.

Dr. C. R. Gildersleeve reported a case in the *Medical News,* Vol. lxxii, in which operation was declined, and autopsy revealed obstruction of the ileum, caused by Meckel's diverticulum, which had become twisted upon itself, and its contents were incarcerated. The diverticulum terminated in a fibrous cord, forming a complete ring through which the ileum passed.

This case, therefore, should hardly be classed as one of disease of the diverticulum, *per se.*

The fourth case in this collection was reported by Dr. J. H. Elliot in the *Boston Medical and Surgical Journal,* 1894. The patient was operated upon four days subsequent to the attack, and died upon the second day following operation. The diverticulum in this case extended from the convex part of the ileum to the umbilicus. It was obstructed and gangrenous.

The fifth case in the series is reported by Guirrard in the *Bull. et Mém. de la Soc. de Chir.,* Paris, 1898, Vol. xxiv.

The patient presented all the symptoms of appendicitis. Was seen in consultation by the operator nine hours after onset of the attack, but was not operated upon until the following day. Patient died. Autopsy revealed a Meckel's diverticulum seventy centimetres from the ileocæcal valve, the distal end of which was adherent to the mesocolon near rectum. The report does not state that the diverticulum was gangrenous, and this case may belong to the class of mechanical obstructions caused by a diverticulum rather than to disease of the diverticulum itself.

The sixth case cited in this series is reported by Dr. W. Mintz in the *Deutsche Zeitschrift für Chirurgie,* Vol. xlviii. This patient, like the others, suffered from intestinal obstruction. A diagnosis of appendicitis was made. He was treated with ice and opium, death occurring on the sixth day. Autopsy revealed a diverticulum sixteen centimetres long and eighty centimetres from ileocæcal valve. Pathological details

are not given, but it was presumably a case of obstruction due to the presence of the diverticulum rather than obstruction caused by disease of the diverticulum itself.

Searching the literature further, I find a case which should be classed with the first case I have related, reported by C. R. Darnall, M.D., United States Army, in the *New York Medical Journal,* January 12, 1901.

His patient was a United States volunteer soldier, twenty-two years of age. He was attacked June 8 with pain in the abdomen, and a feeling of weakness and exhaustion. He was admitted to the Battalion Hospital at Talle the day after his attack. He was then suffering tympany, vomiting, abdominal pain, and tenderness. He was given magnesium sulphate, which he did not retain, and morphine hypodermatically. An enema was used without effect.

Unfortunately, he was attacked on shipboard, and the conditions suitable for operation were not obtained until three days after the onset.

The abdomen was opened in the right iliac region; the cæcum and appendix were found to be normal. The wound was closed. Patient died three days after the operation. Autopsy. Abdomen very much distended. Abdominal wound in good condition. General peritonitis existed. A Meckel's diverticulum was found six inches long, three feet above the ileocæcal valve. The distal extremity was attached to the abdominal wall at the umbilicus. The proximal end bore a large gangrenous patch, near the centre of which was a perforation two centimetres in diameter.

This, then, is a case corresponding to the one which I have reported.

Dr. A. L. Wright, of Carroll, Iowa, reported before the Dubuque Medical Society, June 22, 1899, a case of recurring abdominal crises in a male aged twenty-seven years, upon whom he reported, in the interval following, an unusually severe attack of abdominal pain, prostration, vomiting, and constitutional disturbance. His physicians made a diagnosis of recurring appendicitis, and the operation was performed with the expectation of removing the appendix. Instead, a diverticulum was found three inches in length. The distal end of the diverticulum was thickened and rough, bearing evidences of inflammatory attacks. The caliber at the proximal end was much narrowed. The wall of the ileum at its junction with the diverticulum was extremely thin, but had not perforated. For this reason a portion of the ileum, three inches long, was resected and an anastomosis accompanied by means of a Murphy button. Patient recovered.

In a thesis read before the Faculte de Médécine de Paris by Henri Blanc in 1899, on "Contribution à la Pathologie du Diverticule de Meckel," are collected from various clinics

of Europe, and a few from the literature of this country, records of forty-eight cases of abdominal diseases due to Meckel's diverticulum. Eighteen of these were cases of intestinal obstruction due either to volvulus or invagination of the ileum. Of the remaining thirty, twelve were cases of acute inflammatory and perforative disease of the diverticulum, causing in most of the cases general peritonitis and death. The balance of the series was made up of instances of cysts, tumors, and herniæ, all caused by Meckel's diverticulum. Of the twelve inflammatory and perforative cases, eight were fatal. Three were saved by operation, and of one the result is not stated.

Meckel's diverticulum is usually found springing from the ileum, two or three feet from the ileocæcal valve. It is estimated by anatomists that it occurs in about 2 per cent. of the human species. Rarely it remains patulous and open at the umbilicus, but it generally has a blind extremity and is of varying length. It may be continued as a cord to the umbilicus, or may become attached to the lateral pelvic wall. It is a remnant of the vitellin duct of the embryo which has failed to become obliterated.

From its rarity in the human subject, abdominal crises due to Meckel's diverticulum can never be of frequent occurrence; but it is one of the conditions which the surgeon must bear in mind when making a diagnosis, and when searching in the abdominal cavity for the cause of the obstruction and of the peritonitis. No class of cases demonstrate more clearly the great importance of early laparotomy, for, whether we are dealing with obstruction from a diverticulum or from a general peritonitis due to a perforation, we are dealing with an emergency, every hour the existence of which, unrelieved, adds to the gravity of the situation, and reduces steadily and surely the chances of recovery.

In the twenty-one cases of general peritonitis due to gangrene, perforation, or both, of Meckel's diverticulum, it will be seen that fifteen proved fatal. In none of these fatal cases was an operation performed *earlier than the third day.*

The three cases which have recovered in this country are

Dr. Elliot's, Dr. Wright's, and the one herein reported. The credit for the recovery of this case is due largely to Dr. E. O. Elmer, who acted with great promptness in calling counsel and preparing the family and the patient for an operation.

The abdomen was opened eighteen hours after the onset of the attack, and but little credit, comparatively, is due to the operator, for the result would have been successful in any hands.

Time is of the utmost importance in determining the result of operation in these cases. It is in this class of cases, rather than that of acute and complete obstruction, that dangerous delays are likely to occur, for the inflammatory lesion, even with its fatal outpour into the abdominal cavity, may not produce obstruction; and in the absence of the more alarming obstructive symptoms the physician is more likely to allow himself to wait, in the hope that the trouble may be relieved without operation.

THE USE OF THE SEGMENTED RING IN GASTRIC AND INTESTINAL ANASTOMOSES.[1]

A CLINICAL AND EXPERIMENTAL STUDY.

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AND

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(*From the Surgical Laboratory of the Harvard Medical School.*)

IN 1902 a segmented ring was described by Harrington (*Boston Medical and Surgical Journal,* November 6, 1902), the objects of which were two: (1) To furnish a mechanical aid to assist in the rapid and safe anastomosis of the intestines; (2) to make the contrivance collapsible into such small segments that their subsequent passage through the intestines would be devoid of danger or pain. The favorable reception given the ring by the profession during the past two years has encouraged us to make a report of personal cases to date, accompanied by the results of a series of animal experiments illustrating the process of repair.

Description of Ring.—The ring is made of hard aluminum in four sections. These sections are jointed firmly together by a small bar of steel, which has a shoulder and a screw-thread, and which serves as a handle. The outer surfaces of the ring are grooved to hold the ends of the intestines, which are tied in place by catgut purse-string sutures. The

[1] Read at the meeting of the American Surgical Association, June 15, 1904.

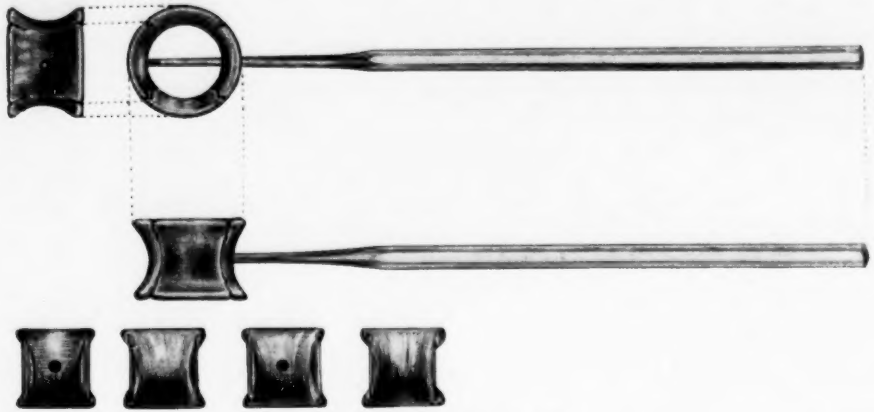

FIG. 1.—The segmented ring.

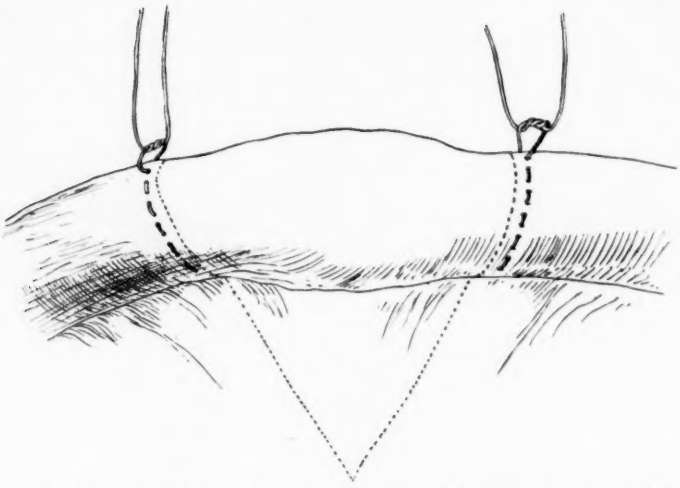

FIG. 2.—Preliminary introduction of purse-string sutures tied with one-half surgeon's knot.

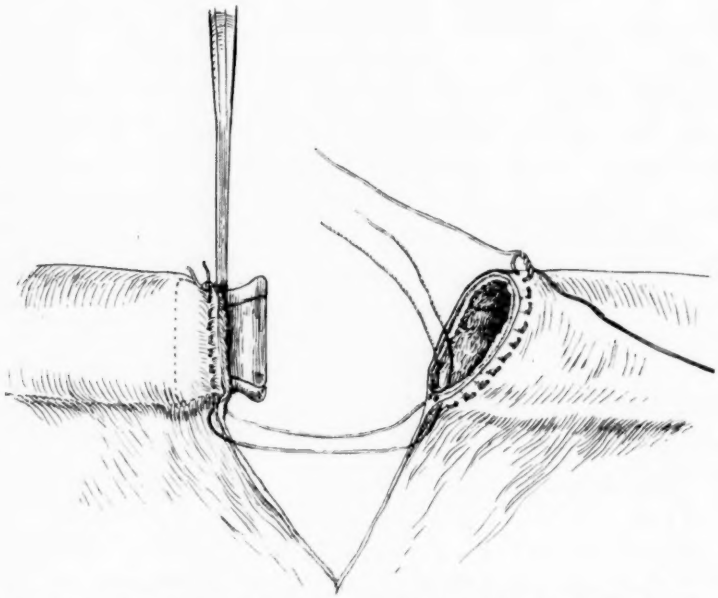

FIG. 3.—Bowel resected, ring half introduced, one gather stitch tied, mattress suture to mesenteric border.

segments fit together by means of sliding tongue-and-groove joints so rounded that they will not cut or catch in the tissues. The ring is made in three sizes. (Fig. 1.)

Diameter.	Width.	Weight of Individual Segments.
5/8 inch	1/2 inch	10 grains.
7/8 inch	5/8 inch	20 grains.
1 1/8 inches	5/8 inch	30 grains.

The middle size is best adapted for general use; the largest may be used for sutures of the large intestine; the smallest size is best adapted for children and for cholecystenterostomy.

ANIMAL EXPERIMENTS.

Technique.—The same technique is used both for end-to-end and for lateral anastomoses; but a slight difference in details makes a separate description necessary.

End to End. Clamps are applied in the usual manner a few inches from the field of operation, and a gather stitch of No. 2 plain catgut is placed on either side of the area to be resected. This stitch circles the intestine with bites deep enough into the muscular coat to insure its not slipping, and, in order to save time later, the catgut is lightly tied with one-half of a surgeon's knot without drawing the purse-strings tight. (Fig. 2.)

The bowel is next cut away up to one-eighth of an inch from the gather stitches, because a wide margin forms a wide inturn and a correspondingly thick scar. The weak point in mechanical aids is the difficulty in obtaining a secure joint at the mesenteric border, a danger which is avoided, with the ring, by putting in a mattress stitch at this spot. This stitch includes a portion of the mesentery on each side, but is not tied at once. (Fig. 3.) The ring is now introduced, and one gather stitch tied. The mattress stitch is next tied, followed by the tying of the second gather stitch. The cut bowels now lie smoothly end to end, and, by use of the handle, can be

easily moved about in convenient positions for sewing. The main stay of the suture is a Cushing's continuous stitch which penetrates the bowel into the muscularis mucosæ. This starts just to one side of the steel handle (Fig. 4) and passes around the intestine with frequent knots until it reaches the handle again from the other side. The handle is now unscrewed, leaving the ring held together by the purse-strings, and the suture continued over the hole just occupied by the handle. The cut edges of the mesentery are caught together by a few interrupted stitches. (Fig. 5.)

Lateral Intestinal and Gastro-intestinal Anastomoses. The gather stitch consists of two parallel arms crossing at one end. These arms are just wide enough apart to allow room for the incision. (Fig. 6.) The mattress stitch is omitted here, and a continuous stitch is employed to approximate the serous coats and form the anastomoses.

Hæmorrhage from the cut edges of the bowel is always controlled by tying the purse-strings, while one or two ties are usually necessary to control the bleeding from the mesentery.

It is desirable to leave the ring in place after finishing the suture, because, although having no influence upon the process of repair, it serves as a splint while the adhesions are being formed. If it causes a decided stretching of the intestines, the ring should be broken down before closing the abdomen. This is easily, and harmlessly, done by gently squeezing the circumference of the ring through the intestine. After twenty-four hours the swelling of the inverted edges of the suture is great enough of itself to hold the ring in place without the catgut purse-strings. The rings examined after one to three days were much more firmly grasped by the suture than they were at the time of the operation. The swelling of the edges of the anastomosis subsides after four to six days, leaving the gut lumen and the purse-strings stretched to a caliber considerably greater than that of the circumference of the ring. The ring accordingly collapses, although the catgut may not yet be disintegrated.

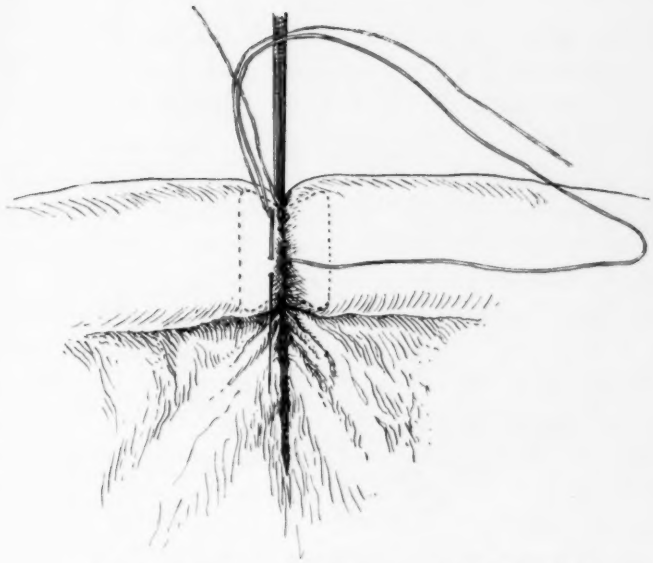

FIG. 4.—Continuous stitch beginning at one side of the handle.

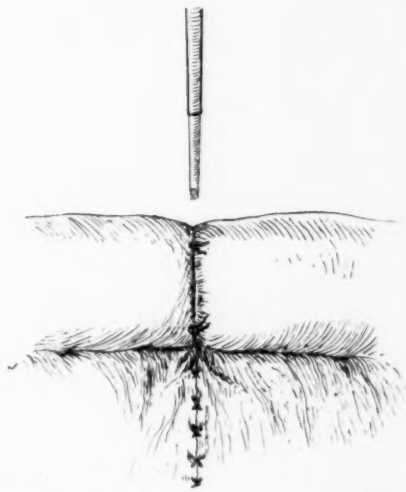

FIG. 5.—Handle unscrewed, suture completed.

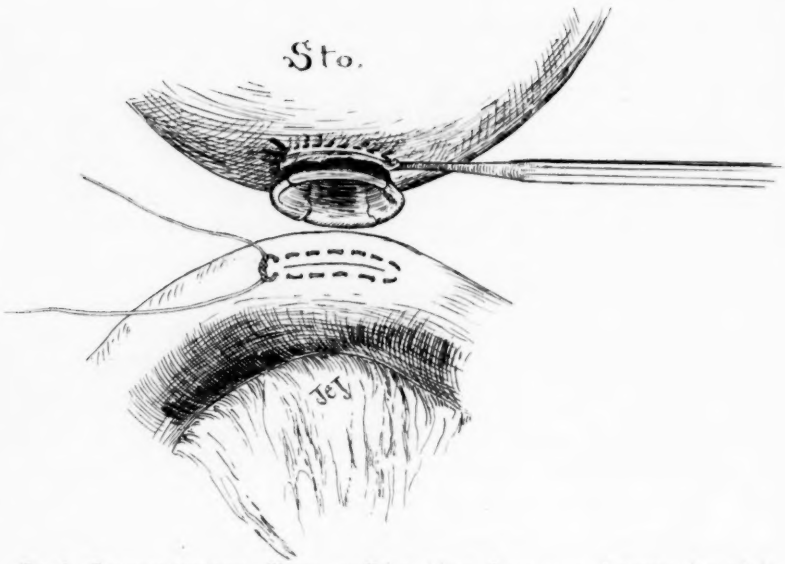

FIG. 6.—Gastro-enterostomy. Shows parallel positions of two arms of purse-string stitch. Purse-string tied on stomach side.

The passage of the segments through the intestines requires from one to three weeks. After gastro-enterostomy some or all of the segments fall back into the stomach, and, if it is patent, pass through the pylorus. That the transit through the pylorus is slow is evidenced by Experiment 17, where three of the four segments were found in the act of passing through the pylorus fourteen days after operation. After end-to-end anastomoses one or two segments pass on together, while those remaining may lie in place at the suture for several days longer.

The suture material used in these animal experiments for the continuous stitch was No. 1 Pagenstecher celloidin thread; for the mattress stitch, No. 1 chromicized catgut. No. 2 plain catgut was found most useful for the purse-string sutures. The rings used were made by Codman & Shurtleff, Boston.

Details of Animal Experiments.—A series of twenty-two experiments are reported below in which fourteen dogs and four cats were used, as follows:

End-to-end intestinal anastomoses	8
Lateral intestinal anastomoses	3
Gastro-intestinal anastomoses	7
	18
Gastrogastrostomies	4
	22

END TO END. (Dogs.)

Experiment.	Time Elapsed after Operation.	Condition of Suture at Autopsy.	Segments Found.
1	1 day	Intact	At site of suture.
2	1 day	Intact	At site of suture.
3	3 days	Slough of suture, too large ring.*	At site of suture.
4	7 days	Intact	Ileum.
5	7 days	Intact	Two in ileum. Two in rectum.
6	8 days	Intact	Ileum and rectum.
7	14 days	Intact	Not found (passed).
8	42 days	Intact	Not found (passed).

* The intestine in this case was so stretched over the ring that it was anæmic. As it was an early case, the importance of breaking down the ring, under such circumstances, was not recognized.

LATERAL INTESTINAL. (Dogs.)

9	5 days	Intact	Near suture.
10	10 weeks	Still alive	
11	4 weeks	Still alive	

GASTRO-ENTEROSTOMIES. (Dogs.)

12	3 days	Intact	Three in pylorus (stomach). One in small intestine.
13	7 days	Intact	Ileum.
14	7 days	Intact	Ileum.
15	10 days	Intact	Rectum.
16	12 days	Intact	Large intestine and rectum.
17	14 days	Intact	Three in large intestine and rectum.
18	21 days	Intact	Not found (passed).

GASTRO-GASTROSTOMIES. (Cats.)

To determine how long ring remains *in situ*.

1	24 hours	Intact	Segments held firmly in place.
2	3 days	Intact	Segments held firmly in place.
3	5 days	Intact	Segment still held in place, loosely.
4	6 days	Intact	Ring broken down. Segments *in situ*.

The Process of Repair.—The close approximation of two serous surfaces, which is characteristic of intestinal sutures, results in a rapid exudation from the apposed surfaces. This exudation appears in a very few hours and hermetically seals the wound. Every coat of the bowel is soon penetrated by this exudate, rapidly destroying the endothelium on the outside of the bowel.

Repair of the Mucous Membrane. For the first few hours after the suture the mucous membrane is the seat of a marked active hyperæmia with more or less bloody extravasation, the mucous edges being dark red and elevated from the coats below. This condition is followed by an exudation which extends into the glandular tissue until, at the end of

three days, the glands disappear about the cut edge for two to five millimetres. When a large invagination has been made, in the process of suture, the submucosa becomes so swollen and œdematous that it probably interferes thereby with the circulation of the mucous membrane. Under such conditions the slough of the mucous membrane is correspondingly extensive. The amount of destruction of mucous membrane varies somewhat; but usually the slough is about three to five millimetres in width. At the end of five days, the slough generally separates, leaving a clean line. The above series of changes takes place in all sutures, although a separate suture of the mucous membrane seems distinctly to retard the repair. The reproduction of glands is more rapid in end-to-end than in lateral sutures. If the inturn has been a moderate one, the mucous membrane will cover in the ulcer in about eight days. The glands themselves, though atypical in shape, possess all the characteristics of mucous glands. At the end of eight days the line of sutures is represented by a narrow scar situated in the middle of what was formerly the ulcerated area. After gastro-enterostomy and lateral intestinal suture, the cleaning away of the slough takes place quickly; but the subsequent ingrowing of the mucous membrane is slow, since the interval to be crossed is a wide one. The process is exactly analogous to the healing of a superficial ulcer on the surface of the body. In these cases mitotic figures were seen at the end of five, but were numerous only at the end of ten, days. The nuclear division, as a rule, first came in the mucosa of the stomach. On the tenth day a single line of cells starts from the stomach and rapidly crosses the floor of the ulcer. The complete closing in of the bare area is much hindered by the presence of sutures, which, even though absorbed, leave irregular holes that are but slowly smoothed over. At the end of twenty-one days the line of suture is covered by a continuous though low mucous membrane. The line of demarcation between the stomach and intestinal glands is a sharp one, and is situated near the centre of the old ulcer. These glands, though atypi-

cally shaped, have normal functional power. (Goblet cells, etc.) (Figs. 7–13.)

The new mucous membrane has no definite muscularis mucosæ. At first it rests upon a base of dense granulation tissue. This coat is very slow to repair; but, at the end of six weeks, a substitute muscularis mucosæ has been acquired, which consists largely of connective tissue, but in which are found fibres closely resembling smooth muscle. This layer has no sharp limits, and fades away into the scar tissue beneath.

Repair of the Serous Surfaces. The formation of plastic exudate does not cease with the resulting adhesion of the inturned serous coats, but appears externally for a distance of three to five centimetres beyond the line of suture, thus acting like an external callus. The transformation of the exudate into granulation tissue is rapid. In three days a large number of new connective-tissue cells have been laid down, among which are a few new blood-vessels arising from the vessels in the underlying muscular coat. Entire organization of the inner exudate requires at least seven, the outer at least ten, days. After complete organization, the connective tissue gradually disappears, finally remaining as a thick scar, which reaches for a varying distance over the adjacent bowel and, dipping down into the depth of the suture, holds the bowel walls firmly together by thick strong bands. Fourteen days are required for the completion of this sequence.

Repair of Muscular Coats. The muscular coats play a passive rôle during the first forty-eight hours after the suture. The muscle bundles are penetrated by extravasated blood and by exudate throughout their whole thickness. After the second day new blood-vessels bud out into the exudate and assist in its organization. When the inflammatory process has subsided, the muscle ends are held together by scar tissue arising from the intermuscular connective tissue. This rapidly contracts and approximates the separated muscle ends, so that

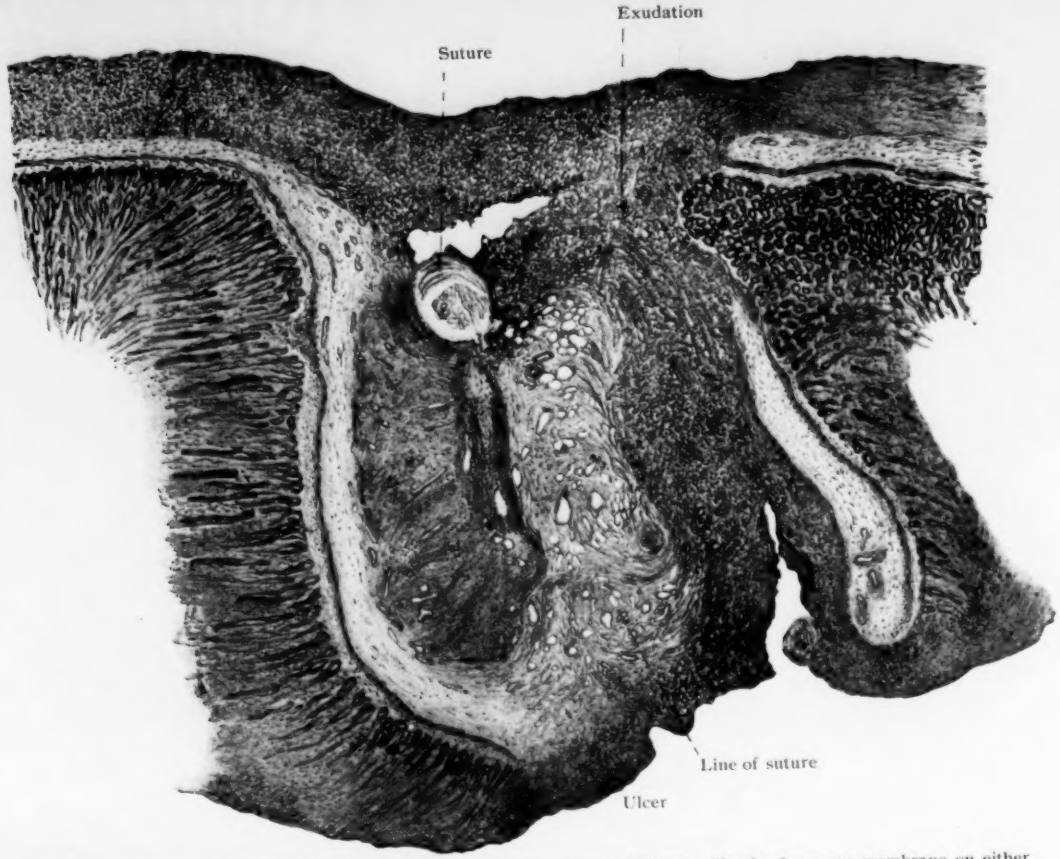

FIG. 7.—End-to-end anastomosis, three days. Note ulcer over inturned edges. Glands of mucous membrane on either side of ulcer necrotic and infiltrated.

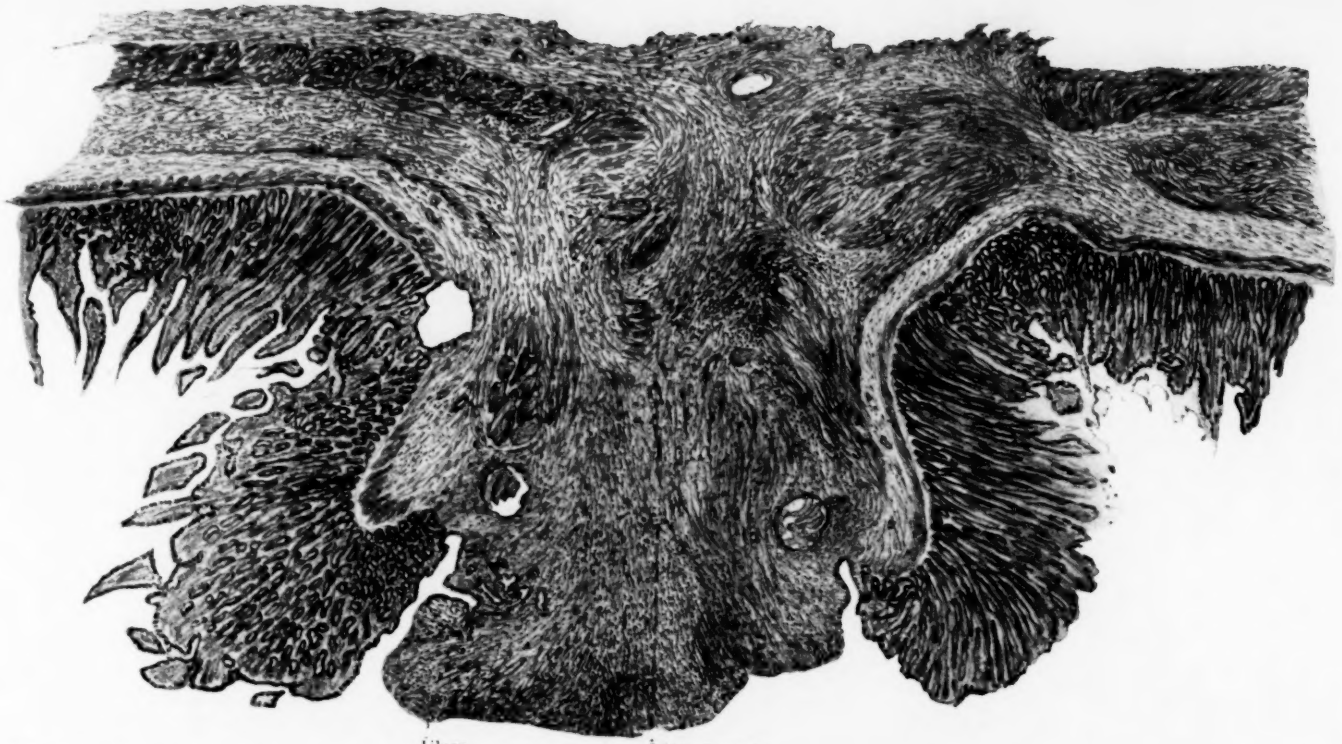

FIG. 8.—Lateral intestinal anastomosis, five days. Exudation almost entirely organized. Ulcer of denser fibrous tissue, new formation of mucous glands at margin.

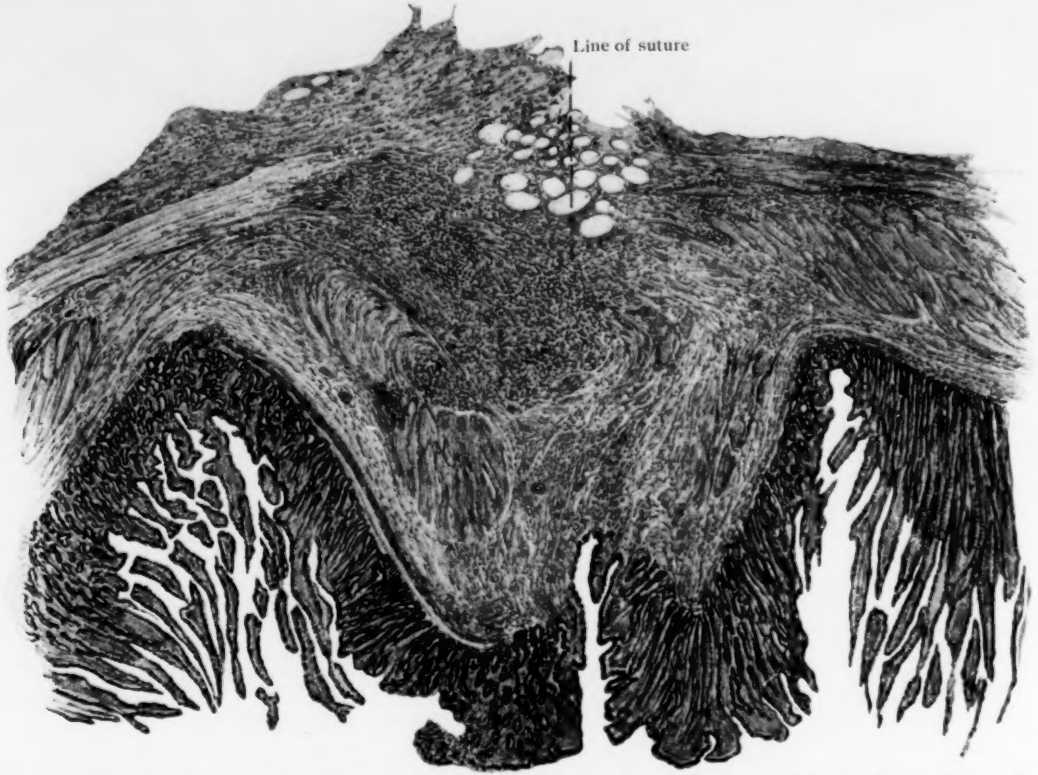

FIG. 9.—End-to-end anastomosis, eight days. Exudation entirely organized. Ulcer covered by newly formed atypical mucous glands.

FIG. 10.—Gastro enterostomy, twelve days. Floor of ulcer formed by infiltrated granulation tissue and covered by epithelial cells arising from epithelium of the stomach. Observe that rate of growth of gastric is much more rapid than that of the intestinal epithelium.

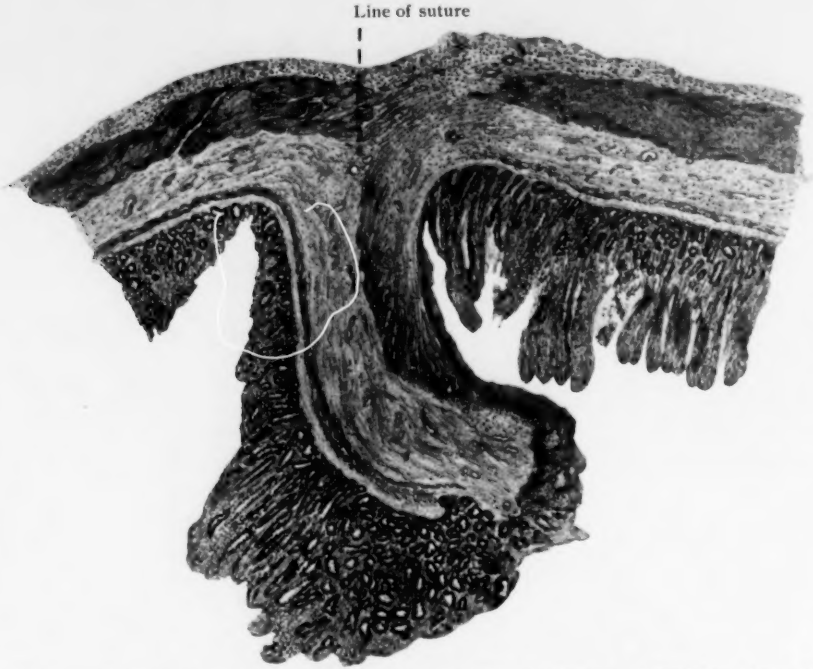

FIG. 11.—End-to-end anastomosis, fourteen days. Marked diaphragm. Granulation tissue contracted down to a dense scar. Diaphragm entirely covered by newly formed atypical glands. Marked inequality in the amount of the intestine inverted on the two sides.

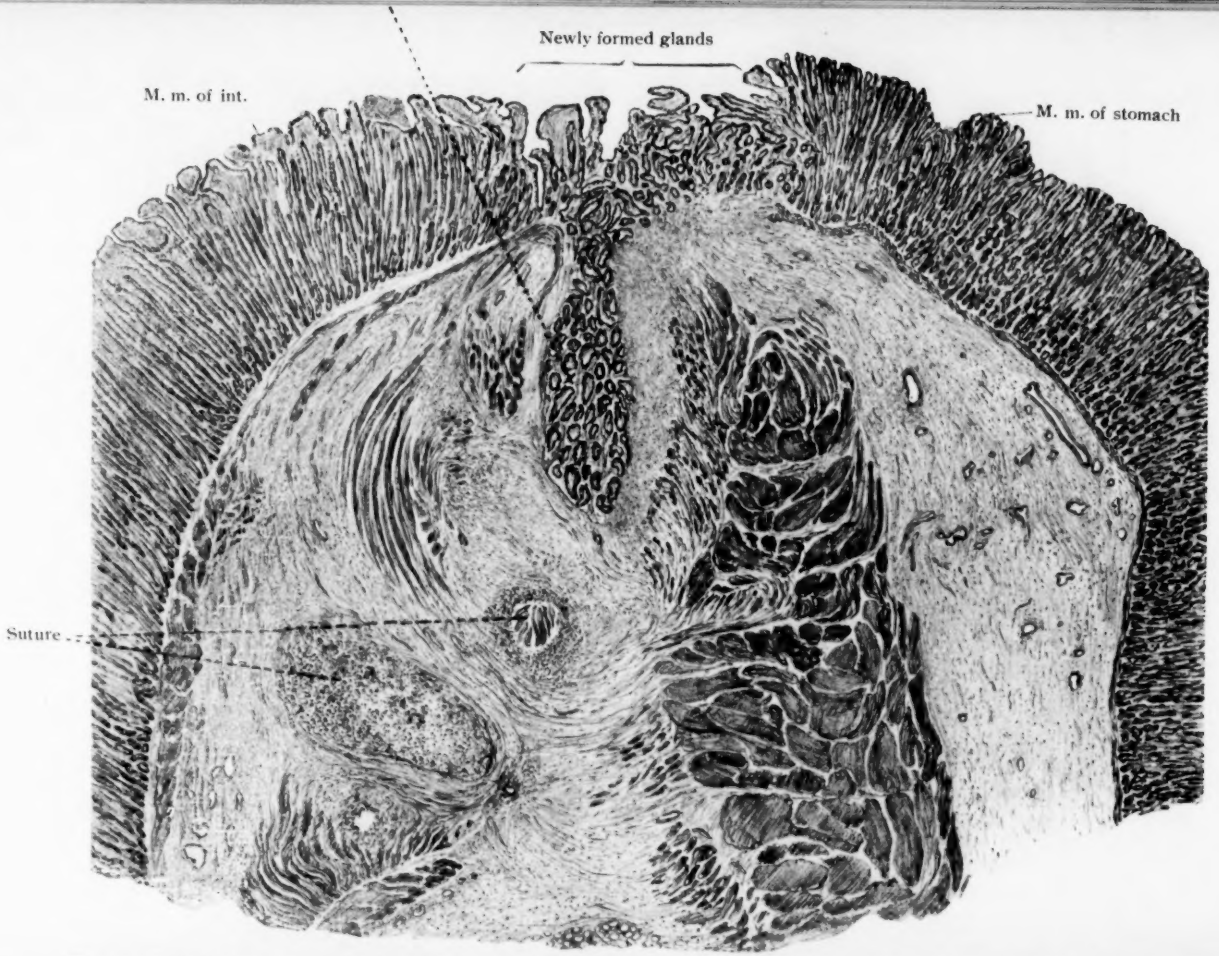

FIG. 12.—Gastro-enterostomy, twenty-one days. Suture held together by dense fibrous tissue, except at the edges, which are covered on both sides with new mucous membrane.

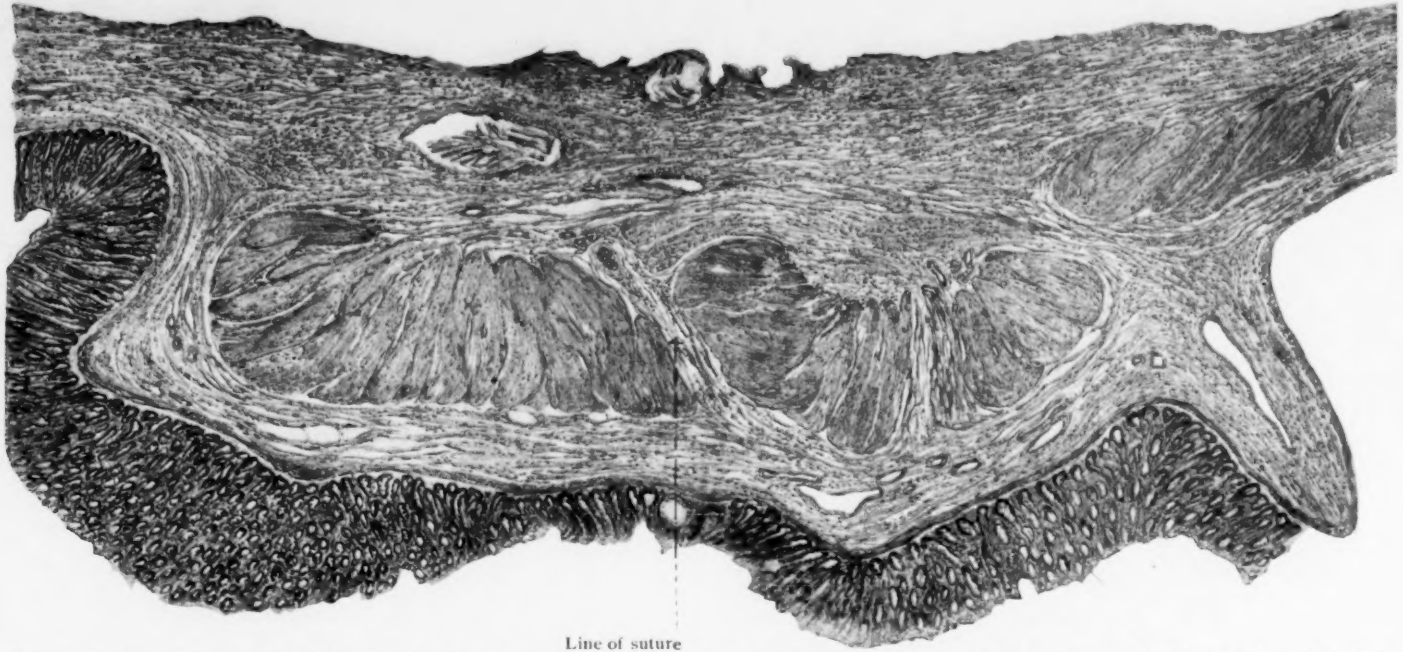

FIG. 13.—End-to-end anastomosis of large intestine, six weeks. The scar is reduced to a thin fibrous line. Inner surface entirely covered with newly formed atypical mucous membrane, thick subserous scar formation (external callus).

the ultimate scar is an extremely narrow one and may be entirely unrecognizable by the naked eye.

Repair of the Submucossa. The loose texture of the submucosa allows easy entrance to the exudate. Almost at once this layer becomes distended and œdematous for several centimetres on either side of the wound. At the end of the inturned bowel this layer is often as thick as all the others combined. As organization proceeds, the submucosa is filled with large and small blood-vessels and young connective-tissue cells, which grow parallel to the surface of the bowel out into the exudate in the bottom of the ulcer, thus forming the base of the internal ulcer. Ultimately the ulcer is converted into scar tissue and is covered by an atypical mucous membrane. From comparison with a limited number of clinically successful intestinal anastomoses in human beings, it seems that the analogy of the process in these animal experiments and in human beings is a very close one, both in histological and in gross appearances.

Advantages of the Ring.—1. Speed. A complete resection and suture can be easily done in fifteen minutes.

2. Cleanliness. Assisted by the clamps, the purse-string suture prevents even a mucous ooze while the continuous stitch is being placed.

3. An intestinal suture is more easily done over the ring than without it.

4. It is safe to use a single layer of continuous stitches, since the ring allows a perfect approximation to be made, and afterwards protects the suture until adhesions have formed.

5. The handle is very useful for holding the intestines in convenient positions for suture.

6. It is not necessary to sew up in layers, since a study of specimens from animals and human beings shows that the mucous membrane will slough in any case, and that repair is more rapid when the mucous membrane is not sutured.

7. The presence of the ring guarantees a free opening at the site of operation.

8. In case the continuous stitch should be improperly applied, the weak spots are protected by the ring itself for at least three days, until the ring breaks down. This allows strong adhesions to form.

9. After operation the ring holds the suture immovable and acts like a splint. The weights of the individual segments of the ring vary from ten to thirty grains, according to size. This is in marked contrast to most other appliances of a similar nature.

Disadvantages of the Ring.—1. General objections to mechanical contrivances.

2. General objections to one layer of sutures.

3. Too large a ring may cause sloughing of the suture from pressure.

4. A foreign body in the intestine is always a source of some danger.

REPORT OF CLINICAL CASES.

CASE I.—*Diagnosis.*—Cancer of pylorus. *Operation.*—Anterior gastro-enterostomy. *Remarks.*—Done at the Massachusetts General Hospital. Recovery after operation.

CASE II.—*Diagnosis.*—Cancer of pylorus. *Operation.*—Anterior gastro-enterostomy. *Remarks.*—Done at Massachusetts General Hospital. Death on tenth day from kink found at suture. Suture intact at autopsy.

CASE III.—*Diagnosis.*—Cancer of pylorus. *Operation.*—Posterior gastro-enterostomy. *Remarks.*—Case of Dr. G. H. Gray, of Lynn. Recovery from operation.

CASE IV.—*Diagnosis.*—Chronic pancreatitis; chronic sinuses leading into colon and stomach. *Operation.*—Posterior gastro-enterostomy. *Remarks.*—Done at Massachusetts General Hospital. Death on seventh day from cachexia, though food was taken at once by mouth and digested. Suture intact at autopsy. Three pieces of ring in ileum, one had passed out.

CASE V.—*Diagnosis.*—Gall-stone attacks and uncontrollable vomiting. *Operation.*—Posterior gastro-enterostomy. *Remarks.*

—Case of Dr. J. W. Spooner, of Hingham. Stomach found contracted to size of intestine and displaced down to umbilicus. Death in three days from uncontrollable vomiting. No autopsy permitted.

CASE VI.—*Diagnosis.*—Cancer of common duct. *Operation.*—Cholecystenterostomy. *Remarks.*—Case of Dr. Philip Mooney, of Gloucester. Recovery. Lived several months.

CASE VII.—*Diagnosis.*—Irreducible intussusception. *Operation.*—Lateral anastomosis. *Remarks.*—Done at Massachusetts General Hospital. Death in a few hours. Suture intact at autopsy.

CASE VIII.—*Diagnosis.*—Intestinal obstruction from cancer of cæcum. *Operation.*—Lateral anastomosis. *Remarks.*—Done at Massachusetts General Hospital. Immediate feeding. Rapid recovery. In good health after several months.

CASE IX.—*Diagnosis.*—Megacolon. *Operation.*—Resection, end-to-end anastomosis. *Remarks.*—Done at Massachusetts General Hospital. Immediate recovery. Later abscess about suture (three weeks). Suture intact. Abscess cavity healed by granulation. One segment passed by rectum three months after operation.

CONCLUSIONS.

1. The process of repair is as rapid after use of the segmented ring as after a plain suture.

2. The time required for the operation is, on the whole, less than that required for a straight intestinal suture.

3. Certain objections, such as weight, ulcer, difficulty of passage, etc., inherent in other mechanical contrivances, are minimized by the ring.

4. The analogy between the experimental and the human observations is so close as to show the propriety of the deductions made from the animal experiments.

5. The employment of the ring in human beings is safe and satisfactory for all sutures.

Many thanks are due to Dr. E. H. Nichols, Director of

the Surgical Laboratory of the Harvard Medical School, for valuable suggestions.

The drawings which accompany this article were made by Miss Florence Byrnes.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY.

Stated Meeting, May 25, 1904.

The President, HOWARD LILIENTHAL, M.D., in the Chair.

TETANUS (ACUTE) CURED BY INTRANEURAL AND INTRASPINAL INJECTIONS OF ANTITOXIN.

DR. JOHN ROGERS, JR., presented a boy, ten years of age, who on April 25, 1904, stepped on a rusty nail, inflicting a wound in the sole of the right foot. The injury was regarded as unimportant, and was not treated by a physician. On the morning of May 2, the boy complained of a stiff neck and back, and experienced a choking sensation. When he was brought to the hospital, at ten o'clock that morning, there was trismus and *risus sardonicus*. An hour after his admission, the patient was given twenty cubic centimetres of tetanus antitoxin subcutaneously in the lumbar region, and at two o'clock in the afternoon a second dose was similarly administered.

The next morning, May 3, there was distinct opisthotonus, rigid jaws, and every indication of acute tetanus. This subcutaneous dosage had not the least effect. The patient was now transferred to Dr. Rogers's care, and at 11 A.M., under chloroform anæsthesia, he exposed the anterior crural and sciatic nerves on the right side, and injected into each about half a drachm of the tetanus antitoxin prepared by the New York Health Department. At the same time, through a lumbar puncture, he injected a drachm and one-half of the antitoxin directly into the cord, working the point of the needle around until the patient's legs were observed to twitch; in other words, intentionally wounding one or more of the nerves of the cauda equina.

On the following morning, May 4, the boy was a little worse. He had had four convulsions during the night, each lasting about ten minutes. The opisthotonus was very marked, the patient was weak and cyanotic, and his condition was extremely bad. The case, apparently, was hopeless. He was again chloroformed, and through a long needle a drachm and one-half of antitoxin was injected into the spinal cord between the second and third dorsal vertebræ. That night he had no convulsions and slept quietly, and the following morning he was able to open his jaws a little. He was also less rigid, and the cyanosis had disappeared. On Friday he was not quite so well. He had had no further convulsions, however, but his jaws were more tightly closed and the rigidity was more marked than on the previous day. He claimed, however, that he felt better. Another injection of a drachm and a half was made by lumbar puncture, and the point of the needle worked back and forth in the substance of the cauda equina. This procedure produced some hæmorrhage from the cord, but there were no ill effects. The patient passed a good night, and on the following day, although he was able to separate his jaws fully a quarter of an inch, another injection was made in the lumbar region as a precautionary measure. His further recovery was uneventful, with the exception of a severe, bluish-red dermatitis which developed on May 9; this involved the trunk and legs, and gradually subsided.

In addition to the above treatment, the initial wound on the sole of the foot was opened and swabbed with tincture of iodine. Pure cultures of the tetanus bacilli were obtained from the secretions of this wound, as reported by Dr. L. Smith, bacteriologist at the Cornell Medical College. The increase in the severity of the symptoms on the second day was probably the result of failure to expose the obturator nerve and inject it with antitoxin as well as the sciatic and anterior crural. The obturator nerve was forgotten, and its charge of toxin was not stopped from entering the cord.

Dr. Lilienthal said he understood that the remedy used by Dr. Rogers was a true tetanus antitoxin, and he raised the question as to whether an antiseptic of any form, for example, lysol, which had been used in cerebrospinal meningitis with marvellous results, might not be worth trying in case the antitoxin was not obtainable.

DR. ROGERS, in reply to a question, said the injections into the anterior crural and sciatic nerves were made directly into the substance of the nerve, so that they swelled up to about the size of the finger. He stated that prophylactic injections of the antitoxin had been reported by several authorities, apparently with good results. Experimental investigations had shown that the tetanus poison was carried through the muscle end of the nerve apparatus; it could only travel in the motor nerves and in a centripetal direction, and the length of time it took to reach the cord was proportionate to the length of the nerve it had to traverse. On this theory, a prophylactic dose of the antitoxin could be given so as to reach the cord before the toxin.

Dr. Rogers said that various antiseptics had been tried more or less unsuccessfully in the treatment of tetanus, although none of them, so far as he knew, had been injected directly into the nerve tissue. The tetanus antitoxin, as prepared by the New York Health Department, was preserved by chloretone; but the percentage of this antiseptic was so small that it probably played no part in the curative action of the antitoxin.

DR. CHARLES H. PECK said the case shown by Dr. Rogers represented a type of tetanus that usually ended fatally, and the result in this instance was certainly very gratifying. In the case shown by Dr. Rogers a month ago, where recovery had followed the same method of treatment, the symptoms had not been so severe. The speaker asked Dr. Rogers if he would select the facial nerve for injection in a case where the point of infection was on the head or face.

DR. ROGERS said he thought it would be entirely feasible, in such a case, to inject the antitoxin into the facial nerve in the region of the parotid, and at the same time into the cervical cord. The mode of death from tetanus was by tetanic spasm of the respiratory centre ,which was some little distance from that of the facial nerve. The speaker said that in a case of cephalic tetanus he would not hesitate to inject the antitoxin directly into the cervical cord.

REMARKS ON APPENDICITIS BASED ON AN ANALYSIS OF 219 CASES.

DR. PARKER SYMS read a paper with the above title, for which see page 727.

DR. LILIENTHAL said he was in thorough accord with the statements made by Dr. Syms. Even if the results of Dr. Ochsner's series of cases treated by the starvation method were remarkable, it did not follow, in the speaker's opinion, that the method was a proper or surgical one. The more he saw of appendicitis, the more thoroughly convinced he was that it was an operative condition whenever the diagnosis could be made. The same rule that Dr. Syms carried out at Lebanon Hospital was also followed by Dr. Lilienthal at Mount Sinai. In cases where the symptoms were evidently receding at the time of the patient's admission to the hospital, an operation was occasionally delayed from hour to hour, but the operation was never postponed, in the hope that the symptoms might recede. An operation was considered much safer than the starvation or any other method.

Dr. Lilienthal said that on his Surgical Division at Mount Sinai he, together with the Adjunct Surgeons, Drs. Elsberg and Wiener, had operated on 455 cases of appendicitis since 1899, with a general average mortality of 10 per cent. During 1902–3 they had operated on 140 cases, with nine deaths, a little over 6 per cent. Of these 140, about thirty-eight were interval cases and the others were acute, and often desperate. The speaker said that was the way in which he divided his cases. He did not quite agree with the division made by the reader of the paper of the cases of general and diffuse peritonitis, for this reason: A general peritonitis might be of a comparatively mild and aseptic type. A tuberculous peritonitis, for example, might be general in character and still not prove fatal. So it was with a streptococcus or staphylococcus peritonitis, or one due to some other pathogenic organism. It was not so much whether the peritonitis was general, or merely diffuse, and not perhaps involving every part of the peritoneum, as it was the character of the infection, and the idiosyncrasy of the individual who was diseased. Some persons could not withstand infection well, perhaps dying from a local peritonitis, while others did not succumb to very severe and almost fulminant forms of peritoneal infection.

Dr. Syms, in his paper, made the statement that every death after operation for appendicitis was a public calamity. Perhaps it was just as well, Dr. Lilienthal said, to put this the other way, and say that every case of appendicitis that got well without an

operation was a public calamity, because such cases induced the public to believe that an operation was unnecessary, and lulled them into a sense of false security.

Dr. George D. Stewart said that in his work at Bellevue and St. Vincent Hospitals he had been treating cases of appendicitis along the same lines as those followed by Dr. Syms, and that the series of cases reported by Dr. Ochsner had not induced him to change his method. Various so-called conservative methods of treating appendicitis had been advocated from time to time, but the speaker said he was in entire accord with those who looked upon it as a surgical condition. Not long ago, a medical man in the French army proved by the statistics of an enormous number of cases of appendicitis that better results were obtained by medical than by surgical treatment. Such statistics, however, were practically of little value.

Not long ago, Dr. Stewart said, a certain surgeon in this city had reported a number of cases of general peritonitis following appendicitis upon which he had operated, with no mortality. Such results were rather surprising, and raised some doubt as to the correctness of the diagnosis. It was well known that general peritonitis in appendicitis was really very rare, owing to the peculiar anatomical relations of the parts. A collection of pus might fill the pelvis and run up the right side of the abdomen as far as the liver, but the cæcum, the ascending colon, and a wedge of greater omentum acted as a natural barrier and prevented it from spreading to the left side. Even through a wide incision such a condition might appear to the operator to be one of general peritonitis, so far as could be told, while as a matter of fact the infection might not have involved the left side of the abdomen at all.

Dr. Stewart said that his rule in dealing with appendicitis was as follows: If the case was a severe one, operate at once. If it was a mild one and not getting worse, watch it carefully for a short time; if it gets worse, operate; if the symptoms remain stationary, do not delay the operation too long. In other words, he advised operation in every case unless the symptoms were distinctly improving when the patient came under his care.

Dr. Rogers said that most of the surgeons in this city were probably in close accord with the views expressed by Dr. Syms and those who had discussed his paper. The only difference of

opinion that might exist was in reference to the use of drainage. He had observed that the younger surgeons were much more inclined to dispense with drainage than the older men.

Dr. Benjamin T. Tilton said that his rule in operating for appendicitis was practically the same as that outlined by Dr. Stewart. As regards drainage of the abscess cavity, he now favored the use of a small wick, or a piece of rubber tissue, in preference to extensive packing, which plugged the cavity and necessitated a painful after-dressing. As far as flushing was concerned, he thought it should be avoided excepting when the exudate was limited to the pelvis.

As regards the proper time to operate, Dr. Tilton said he thought an early operation was always advisable unless the patient was undoubtedly going on to recovery. In cases of abscess formation, simply opening the abscess was in many instances the safest procedure. The speaker said he could recall a number of cases where this was done and there was absolutely no return of the trouble. It was ofttimes undoubtedly a life-saving measure, and he thought it should be more commonly done, especially in cases where the surgeon was called in to operate under inopportune circumstances.

Dr. John A. Hartwell said that in suppurative cases of appendicitis the starvation method of treatment recommended by Dr. Ochsner might prove valuable after operation. In such cases, where the feeding was done per rectum and the patient was only given a little ice by the mouth, the speaker said he had been struck by the lack of abdominal distention, and the more rapid subsidence of all the acute symptoms.

Dr. Peck said that in cases of appendicitis with abscess formation, especially in the retrocæcal type of abscess, where the appendix was often destroyed, it was well, he thought, to follow the suggestion made by Dr. Tilton, and simply open the abscess, in those cases where the appendix could not be easily shelled out. The rest of the peritoneal cavity should be walled off and protected before opening the abscess. When there was no well-defined abscess and the appendix was buried in a mass of recent adhesions, the speaker said he depended a good deal on the sense of touch in delivering the appendix, and did not, as a rule, wall off the field with pads. The operative field could then be cleaned by either sponging or flushing. In cases where the exudate was

spread out over a wide area, the cleansing could be done with less trauma by flushing than by swabbing.

Dr. Peck said it was often difficult to distinguish between a diffuse and a general peritonitis. Recovery was not infrequent after a peritonitis involving the entire pelvis and right side of the abdomen. The entire abdomen, as Dr. Stewart said, was comparatively rarely involved in the process.

The speaker said he favored the use of a small drain down to stump or in abscess cavity. He was becoming convinced of the fact that a small drain was equally if not more effective than a large mass of gauze.

Dr. John D. Rushmore said that in many cases of appendicitis the surgeon had no choice as to the time of operation. The family physician was usually first called, and if, after three or four days' treatment by various methods, the symptoms became aggravated or were not relieved, the surgeon was sent for and had to accept the situation as he found it. Personally, Dr. Rushmore said, he believed in operating early: he considered the risk of waiting to be infinitely greater than that of operating. It would prove a valuable object lesson to the physician to witness more of these operations, and see how far advanced the condition was before surgical aid was invoked. Many physicians, apparently, fail to recognize a tumor in the abdomen, even after it has become quite perceptible to the surgeon.

The onset of an attack of appendicitis was usually figured from the time when the pain begins, and this Dr. Rushmore thought was a grave error. The actual onset of the disease in many cases probably antedated the pain by days, and perhaps weeks. He compared the changes that took place in the appendix in appendicitis to those that occurred in the small intestine in typhoid fever. In an attack of typhoid fever, no one would be able to locate an ulcer of the intestine, although present for many days, and it would be manifestly improper, when rupture occurs, to call that day the first day of the disease. In appendicitis we have an analogous condition.

It was not unusual to see a case of appendicitis run its course, and then, after the patient had apparently recovered, and all the symptoms had abated, to find, on operation, a deep ulcer of the appendix on the point of rupturing. These conditions occurred as the result of the so-called conservative or expectant treatment,

and many of them after the starvation method had been employed for three or four days. The speaker recalled a case upon which he had operated recently, where the only symptom was abdominal tenderness. The pulse was 72, the temperature normal; there was no tension; no tumor. Still, upon operation, the mucous membrane of the appendix was found to be gangrenous from the root nearly to the tip. The so-called interval cases of appendicitis were frequently found not to be interval cases at all; the appendix was found to be kinked or strictured or ulcerated.

Dr. Syms said there was a smouldering tendency on the part of many physicians to seek some excuse for delaying operative interference in appendicitis. In 1901, at a meeting of the Surgical Section of the American Medical Association, no less an authority than Dr. Senn, of Chicago, made the assertion that there was entirely too much operating in appendicitis, and stated that 20 per cent. of all cases of appendicitis would recover without an operation. This statement was met by a storm of applause, which showed the strong sympathy with such dangerous views even in a surgical gathering of that kind, and it was not until the surgeons had rallied, and Dr. John B. Murphy, of Chicago, had called attention to the fact that Dr. Senn's statement implied a terrible mortality of 20 per cent. without operation, that the meeting came to its senses, and realized that no statistics could be based on the number of recoveries without operation. A single patient may have recovered from ten or a dozen attacks of appendicitis, and these recoveries may figure in various statistics, but without operation, such a case may go on to inevitable mortality. Ochsner compared his series of cases treated by the expectant method with a similar number treated by Deaver by operation, and showed that, according to his figures, his results were better than those of Deaver. His conclusions, however, were open to the objection that in Deaver's cases the exact condition was actually observed, while in his own it was not. Surgery discloses the exact condition present at the time of operation.

Some years ago, Dr. Syms said, he wrote a paper on this subject, entitled, "When to Operate," in which he attempted to classify the cases that would recover without operation, and which could be safely treated expectantly, and those that would require operation. To-day he had come to the conclusion that there was only one thing to do when the diagnosis was made, and that was

to operate. This rule might be modified, perhaps, under special conditions, but not otherwise. Given an acute inflammatory condition in the abdomen, there was only one way to ascertain its extent and seriousness, and that was to operate. In no other way could the exact condition of affairs be learned.

DR. RUSHMORE said he did not think that statistics comparing medical and surgical cases of appendicitis were of much practical value. The cases that recovered under the starvation method were probably picked cases. The only proper comparison between medical and surgical statistics is afforded by having a certain number of cases treated from start to finish by the physician and the surgeon, and not to have the cases turned over to the surgeon after the ideal time for operation has passed. And we must also remember that barring those few cases of appendicitis terminating in suppuration and that open into the intestines, bladder, etc., if the surgeon did not interfere, the case would almost always terminate fatally, and would be fairly counted as a medical death.

DR. SYMS called attention to the fact that all of Dr. Ochsner's cases were subsequently operated on.

DR. LILIENTHAL said that in spite of that fact they were picked cases, and if they had gotten worse under the starvation method of treatment, they would probably have been operated on without delay.

REVIEWS OF BOOKS.

LEHRBUCH DER SPECIELLEN CHIRURGIE FÜR AERZTE UND STUDIRENDE. Von DR. FRANZ KÖNIG, Berlin. Achte Auflage. I and II Band. Berlin: Verlag von August Hirschwald, 1904.

Four years have elapsed since the sixth edition of this extensive treatise on Surgery made its appearance, and for the first time the first and second volumes are published in the same year. This has been made possible by the aid of Professor König's son, Professor Fritz König, in Altona, who has co-operated with his father in the production of the second volume. The third volume is promised for the latter part of this year.

Volume I treats of the surgical diseases of the Head, Face, and Neck. It contains 803 pages of text. The changes to be noted in this volume are comparatively few. The volume might be improved by the addition of up-to-date illustrations and a good index.

Volume II, containing 941 pages, is devoted to the Surgery of the Thorax, Abdomen, and the Male Genito-Urinary Tract. The revision of this volume has been much more extensive than that of the first volume, although the American surgical teachings seem to find very little place even here. The chapters on Peritonitis and Intestinal Resection have been revised, but some of the more recent American operations are not mentioned. The chapters on Abdominal Tumors and Surgical Diseases of the Male Genito-Urinary Tract have been thoroughly revised.

Dr. Nitze has written the section on Cystoscopy.

Dr. König's Surgery has long been recognized as one of the standard German works, and it may be described as practical, systematic, and complete.

PAUL M. PILCHER.

ÉLÉMENTS DE PATHOLOGIE ET DE CLINIQUE CHIRURGICALES. Par le DR. LEON MOYNAC, Ancien interne des hôpitaux de Paris, etc. Eighth Edition. Three volumes. Pp. 2000. Illustrated. Paris: G. Steinheil, 1903.

Under this title Dr. Moynac presents the eighth edition of a work that has had a steady circulation as a text-book for students in France. As the title indicates, the work endeavors to place before the reader in a concise manner the clinical aspect of surgical affections, together with the general and special pathology of each.

The broad principles of surgery and pathology, as accepted by recognized authorities to-day, are presented first in a clear and comprehensible manner, including the fundamentals of asepsis and antisepsis. Then follow the surgical diseases, and, lastly, the injuries, neoplasms, etc., arranged anatomically. The author covers not only the ground assigned to the general surgeon, but also devotes considerable space to the special branches, as the eye, ear, and nose.

Altogether, the three volumes, in arrangement, size, and material, constitute an acceptable addition to the working library of either practitioner or student.

HENRY GOODWIN WEBSTER.

RADIOGRAPHY AND PHOTOTHERAPY, INCLUDING RADIUM AND HIGH-FREQUENCY CURRENTS. By CHARLES W. ALLEN, M.D., New York. New York and Philadelphia: Lea Brothers & Co., 1904.

The present volume is the product of three men,—Dr. Allen, who is Professor of Dermatology in the New York Post-Graduate Medical School; Milton Franklin, M.D., of the New York Polyclinic Medical School, and Samuel Stern, M.D., Radiotherapist to Dr. Lustgarten's clinic at the Mount Sinai Hospital.

At the present time, when the subject of radiant energy is

engaging the attention of so many investigators throughout the world, the publication of the present volume is very welcome.

In Dr. Allen's book the practical and technical side of radiography has been briefly treated, and there has been more space given to the therapeutic effects. Elementary electrophysics and shadow pictures have been omitted, and the subjects of Radio-activity and High-Frequency Currents are considered at length.

As the science advances and our experience broadens, we are able to state in more exact terms what the dosage of a therapeutic agent should be, and this, as shown by the author, is equally true in this branch of therapeutics.

The volume is divided into seven parts,—General Consideration upon Radiology, Diagnosis, Radiotherapy, Light, Actinotherapy, Radio-activity, and High-Frequency Currents.

The first few sections present nothing especially new, while the chapters on Radio-activity and High-Frequency Currents are very interesting and instructive. The book will find its greatest usefulness in the hands of those who have already mastered the elements of the science.

PAUL M. PILCHER.

MEDICAL DIAGNOSIS: A PRACTICAL TREATISE FOR STUDENTS AND PRACTITIONERS. By JOHN H. MUSSER, M.D., Professor of Clinical Medicine in the University of Pennsylvania, etc. Fifth Edition. Pp. 1213; fully illustrated in colors. Philadelphia: Lea Brothers & Co., 1904.

There may properly be some difference of opinion as to the form which a treatise on diagnosis should take. One may justly claim that between the covers of such a book should be found everything which can bear upon every form of disease, but in the arrangement of this material lies its real value. The student will look for the logical development from the single symptom to the group that characterizes the disease, and the comparison that distinguishes similar groups. He may expect greater detail and a

more discoursive treatment, the analysis of individual symptoms in their relation to the entire complex, and the discussion of the relative value of each. Such a treatment of the subject is eminently scientific and scholarly, but it tends rather towards the Practice of Medicine than Diagnostics. Those who turn most eagerly to a book of reference are the puzzled practitioners who have no time for deliberate study, and welcome a system that makes it possible, by the consideration of a few cardinal symptoms, to apply their already acquired technique in the briefest time and with the least exertion.

Just how far laboratory methods should enter into general practice must rest with each practitioner. There can be no question of the desirability of routine examination of all the available secretions, but this requires time to do properly and skill to execute, and unless painstaking, deliberate, and accurate, such examinations are more than useless. The younger generation is being taught all this, and in time it will be possible for every physician, if not already himself equipped, to call to his aid some one who is.

Turning from such general considerations to the consideration of "Medical Diagnosis," one is first of all impressed with the vast amount of material here accumulated, and the evidences of painstaking care in its classification and arrangement. We are assured that the entire book has been rewritten and rearranged along the lines that one would naturally employ in taking a history, and that the illustrations have been doubled.

Of the 1213 pages, 700 are devoted to the methods and instruments of diagnosis, 482 to the diagnosis of special diseases, and 31 to a good index. Nine pages, including six plates, four of them skiagraphs, are devoted to the Röntgen ray in medical diagnosis. The chapter is eminently suggestive and helpful. It would be impossible to specify each point of excellence without reproducing the entire book; but in glancing here and there one is struck with many desirable innovations, such as the table of

graphic symbols used in representing the phenomena of physical examination.

If adverse criticism is permissible on so excellent a work, it may be said that, in spite of the rearrangement of the contents, there is still a lack of compactness, a tendency to amplification both in text and illustration that makes a cumbersome volume and hampers ready reference. Additional cross references would be desirable. Judicious compression would improve it.

HENRY GOODWIN WEBSTER.

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Remittance for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY,

227–231 South Sixth Street, Philadelphia.